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CAPTAIN SIR GEORGE NARES AND POLAR DISCOVERY.

ENGLAND entered upon Arctic Exploration in the reign of Henry VIII., and the object was the acquisition of wealth, or the aggrandizement of territory. The gain depended on discovering a passage to China by the North-East route, in accordance with the idea of Horne, who wrote in the year 1525 a treatise to prove the practicability of penetrating to India across the North Pole. Sir Hugh Willoughby undertook the enterprise at his own request, under the auspices of the company of merchant adventurers in 1553—the King Edward VI. endorsing the command by a license to discover and hold strange countries, islands, etc. He was accompanied by a council of twelve, who were speculating merchants. Storm and famine destroyed them all, with the exception of a few common seamen belonging to Chancellor's vessel the *Bonaventura*.

Sir Francis Drake returned from the early voyages to the West Indies in 1578, and by his influence at Court, aided by his friend and fellow-voyager Hawkins, then treasurer of the navy, succeeded in obtaining for Martin Frobisher the charge of an

expedition in the opposite direction—North-West—under the impression that the whole continent of America consisted of a land of precious metals. He also furthered Sir Humphrey Gilbert's adventure to Newfoundland, and actually wrote a sonnet recommending the business to investors who wished "to make gold." No doubt he was jealous of the influence of the Portuguese and Spaniards in those northern regions, for these, under the colour of fishing, were despoiling and acquiring what Sir Francis and Queen Elizabeth deemed to be as much the right of England as of any other foreign power. Then followed Davis's three years' labours, the Dutch Voyagers, Hudson, of Hudson's Bay, who also tried by way of Spitzbergen; Baffin, of Baffin's Straits; Behring, of Behring's Straits; Middleton, Cook, Vancouver, Ross, Parry, Franklin, and Back. These aimed at the north-west passage from one side or the other, and not at the North Pole. The object in view did not extend beyond discovery, and that chiefly concerned commerce. Gradually the public interest became awakened to the value of scientific observations, as it became increasingly evident that the search for wealth had not there a profitable opportunity; and in 1818 the general impression of the English public decidedly avowed that however interesting the work of discoverers in the Northern Seas might be from a philosophical point of view, it could only be regarded as an object of curiosity not likely to lead to any useful or practical results; but that it befitted a great nation to enhance its store of geographical knowledge, in order to extend the basis of natural science. This conclusion may be said to have originated from the zeal of Daines Barrington, who from 1773 to 1818 had persisted in bringing before the Royal Society the subject of approaching the North Pole by the other direction—the north-east—and now at the end of sixty years, or a century from the commencement of his exhortations, the public mind is turning to his papers and his book as affording a much more reasonable probability of success than the north-west, although some hundred expeditions have elected to persevere in that course.

And here, before going further, it is due to the glory of the Dutch that a word be spoken. England in the old days had a just antipathy to the aggressive tendencies of that nation, for they gave us much trouble; but the student of the world's doings would indeed be ungracious if he refused a tribute of praise to that enterprising people. Motley has done much in that direction, but he who has to treat of the Northern Seas must yield to those shrewd practical men not only the glory of developing the hidden wealth of the earth, but of doing all it could, as the then Queen of the Seas and the money market of the world, in developing the unknown for the advantage of mankind. Von Campin has recently published an excellent work on *The Dutch in the Arctic Seas*, which has been repeatedly noticed in the *Athenæum*, and unto him solely belongs the honour of collecting and making available the untold fragments appertaining to the service of his nation in those perilous waters.

The Dutch seamen employed in the Greenland Fishery never heard of a perpetual barrier of ice north of Spitzbergen; and their common latitude for catching whales, 80½ degrees, they said led them to believe in an open sea from thence, for they often proceeded several degrees beyond it. And north of St. Petersburg, it is averred that the farther voyagers go the warmer is the climate; beside which they declare that the north wind always brings a thaw. We have ancient evidence in corroboration. Men throwing off their winter garments when passing 80 degrees, and having no need of them until they return to land again in May, supply proof indisputable that human energy under hardier conditions than ours had a faith we have not yet acquired. We have yet to learn what our fathers knew; that, in enterprise, the less you are burdened with self-preservation and self-indulgence, or amusement, the likelier are the chances of the future crown. That crown is not yet won; but very much has been contributed, and in regard of that we will turn our remarks in the direction of modern energy and the acquired or probable results.

Ross came home in 1833, after an absence of four years; and Back returned in 1835. The interests of science demand a notice of these expeditions before we pass on to that of Sir John Franklin, who discovered the North-West Passage. Ross's first expedition produced no other fruit than to transfer the public confidence from himself to Sir Edward Parry, whose work stands among the most successful in Arctic exploration (for he reached 82·45 degrees), and an equal rank to Back and Franklin. Smarting under the chagrin Ross induced Sir Felix Booth, the distiller, to fit out the expedition above noticed at his private charges, which charges were ultimately supplemented by Parliament, and by the promotion and rewards of the individuals who had been therewith connected.

The revival of the Arctic explorations is due mainly to Sir Joseph Banks, a man who possessed most worthily the confidence of the nation. Consulting with Herschel and others he obtained necessary authority; and Commander John Ross went out in the *Isabella*, 385 tons, and the *Alexander*, 252 tons; the first under his own command, and the other under Lieutenant Parry. J. C. Ross accompanied as a midshipman. Ross's narrative in itself ought to have prevented any further connection with the Polar voyages, for he says—"My nautical education has taught me to act and not to question, not to discuss probabilities, or examine philosophical or unphilosophical questions. I have attempted nothing more than the journal of a seaman; if I had done more, I might have done worse." This was a pretty conclusion to an effort for enlarging the field of science and discovery, which had baffled the best of men for three hundred years. Parry had some qualifications, for, unlike Ross, he had been in Northern Seas, and like Captain Nares, had shown aptitude in his profession by his treatises for the use of young officers in the fleet on nautical astronomy, etc. He was mortified, however, at the conduct of the expedition, and disappointed at finding a total want of all facilities for collecting observations on science and geography, and the careless flippancy that prevailed. No result followed. Sabine joined as a volunteer, and although bitterly disappointed and grieved rendered good service by his subsequently published notes. Ross ran away home, took credit for the notes made by everybody but himself, got to himself promotion, and afterwards hindered everybody else.

In the same year (1818) Buchan and Franklin took the command of the *Dorothea* and the *Trent* respectively; the latter having under him Beechy and Back. Franklin had seen service, having been at Copenhagen and Trafalgar under Nelson, and at New Orleans, where he was wounded; was a good nautical surveyor, well versed in the use of instruments, and a thorough seaman. In the following year Parry followed in the *Hecla* and *Griper*, with instructions to do what Ross had not done under instructions—examine Lancaster Bay, Jones' Sound, and Smith's Sound. His vessel, of 375 tons, left on the 11th May, with Beechy, Clarke, Ross, and Sabine, on duty, and went straight to Lancaster Bay; and his book on a voyage so novel, perilous, and precarious, is one of the best of its kind. Specimens were collected such as had not been before; the only knowledge Ross ever had of the Magnetic Pole, save what he interpolated from his nephew, was gleaned; and had Parry been aided by modern instruments, it is evident that his labour would have actually served science better, for, as they have not done, he indicated the way. His instruments indicated the Magnetic Polar Point as 100 degrees W. Greenwich, and young Ross made it, within two or three degrees fifteen years after, by actual survey. But Parry's labours did more: he taught the formula for making scientific observations, and it is a known authority. In four months he crossed the line of 74 lat., and became entitled to the royal premium of £5000, and they named the point Bounty Cape. He too established the custom of amusements on board, and the officers became stage managers; he started the idea of ship newspapers or magazines, in which everybody was free to say what they pleased without any fear of official rebuke; Sabine was editor. Sabine here wrote his magnetic observations, Experiments on the Pendulum, and Natural History Notes, set up an observatory, etc. The men took to hunting, and found sport, save in the extreme north—beguiling the ten months of the ice-desert winter as best they could, and it is most interesting to note the progressive knowledge they supplied for future voyagers. They had in their latitude more than 86 degrees frost, and not much comfort compared with modern supplies; and the dreariness endured far surpassed anything now possible, and, moreover, they had there a darkness of eighty-four days. He had only one case of scurvy, which was cured by limejuice, vegetable soups and fruits, and a growth of mustard and cress in the warm cabin. As soon as possible after winter the company returned home, protesting against western travel as a means of gaining the open sea.

He undertook the second voyage bent for the discovery of a North-West Passage in the celebrated vessels the *Fury* and the *Hecla*, and did remarkable surveying work, making sure that there was a way through; and his experiences of men under those singular circumstances are the model instruction of all who succeed; how to protect, employ, amuse, and improve them, by which, more than by other agencies, he could repel scorbutic and other diseases. This was followed by a third voyage in 1824-25, with the same object, of which we cannot spare room to speak; but contemporaneous with that of Franklin, he undertook a more daring expedition, which had for its object, "To reach the point of the earth furthest removed from mortal view—the centre of the regions known as the Pole of the Earth;" and a most illustrious voyage it was. He reached up beyond Spitzbergen the highest latitude, 82·40 degrees, that had

ever been known, and found floe travelling to be impossible beyond that. But the reader could not expect that with his 350 ton ship he could do more than he accomplished.

But with the tenacity of the English nation more must be attempted. Franklin went out, and for the North-West Passage. He describes the most striking phenomenon upon the coast between the Mackenzie and Coppermine rivers as "the *burning cliffs* seen in several places, and often on a great scale, giving out their warm vapours to mingle with the freezing air of the icy sea." The process is chemical, and the result alum, of which those rocks are a vast manufactory; there is a species of bitumenous shale, impregnated with sulphur, existing in a state which causes it to have a strong attraction for oxygen, resulting often in spontaneous combustion." Upon his return he received the honour of the Queen and people. He was a great and capable self-denying man, to whom there is no comparison, and all who know Arctic matters will recognise in him the man who made manifest the North-West Passage, and one whose scientific capacity very far surpassed every observer of phenomena in that region. He could not be permitted to rest. Life for him had its attractions; for it was his happiness to be blest with the fellowship of the noblest of women; but the country demanded his service, and in 1844, on the 12th December, there came instructions to proceed with the *Erebus* and *Terror*, the first of 378, and the second of 326 tons, to the North Seas. The ships had been with Ross and Back, and he was, at fifty-eight years of age, ordered on the North-Western Exploration. Friends in England appealed to Lord Stanley (late Lord Derby) begging leave to follow, for they felt he was gone never to return unless delivered by cross supplies. By-and-bye there came a letter from Franklin—the last he wrote home—26th July, 1845, latitude 74 degrees, longitude 66 degrees, Baffin's Bay, and his friends instantly repeated their requests to send on aid, complaining of the official indifference manifested, and protesting against sending such a man into a dangerous region without any provision for collateral or contingent aid. Lady Franklin advertised rewards of thousands when the Crown had avowed its contempt; and adventurers, by scolding the Admiralty, rivetted the mischief. No doubt if relief had been sent land-wise through Hudson's Bay to the Great Fish River, it would have been contingently salvation. As for the aid of Ross, that was of all things ridiculously contemptible. The sorrowful ending we know, and do not care to discuss. The nation loved Franklin and distrusted Ross; and the nation lost the brave man, and made the other a Swedish consul. Franklin had Faraday's directions, which he would and doubtless did obey; and he had those of other men of note, but the papers are not yet recovered. They probably will be, notwithstanding the unwisdom of attempting Polar Discovery by way of West Greenland.

We propose now to abridge the interesting matter resulting from the recent Arctic Expedition, and to indicate suggestions in reference to the future; but our remarks must be confined to the bearing on science. The hardships of the enterprise were very exhausting. Every one knew they would be so. Arctic climate is not agreeable to natives of the temperate zone, and investigations conducted over whole tracts and mountains of ice or glaciers, or amid floes or icebergs, make fearful demands on physical endurance.

After a long controversy on Arctic Expeditions, the nation determined on one more in spite of the protests of utilitarianism, and the questions to be solved were, Who should be the Captain? and by what route should they go? The *Challenger* had, under Captain Nares, done very great service to science in the far east and south, and had also powerful credentials. In the first place he, in the Arctic Expedition of 1852, 1853, 1854, was mate, and made himself popular by his faculty for giving pleasure, and his sledge-work, in which he did about 200 miles in 3 weeks. Ten miles a day seems to be the acme of Arctic labour, for in the following year under a Lieutenant, only 670 miles were done in 69 days; and in 1854, 586 miles in 56 days. But this position gave him a claim, in the routine rank of the Admiralty, for promotion, because Osborn, M'Clure, M'Clintock, were no longer available, and he remained the connecting link in the open rank of Polar Crown Service at that time. He had done many valuable surveys after returning from the Arctic seas in the southern hemisphere, and afterwards in the Gulf of Suez. These events led to his appointment as Commander of the *Challenger*, a scientific enterprise which hoped to extend the certainties appertaining to oceanic laws and meteorology. He was recalled when at Hong Kong to take charge of a great national effort to eclipse all previous acquisitions of knowledge in the branches of modern thought, described in the instructions hereafter cited about the Arctic region, for which he was especially qualified by the successes of his eastern and southern labours.

When Lieutenant on board H. M. Ship *Britannia*, Nares complied his "Naval Cadets' Guide," a useful book for instructing young officers in the navy during their time of study, in which is set forth the names of all parts of vessels, whether as to construction, rigging, or fitting; and the necessary description of all terms used in navigation, and in the management of ships; the rule of the roads; and in fact, every department in an intelligent seaman's education. The work is the more valuable from the 140 illustrations delineating the form of every part of the tackle and the mode of working. It is a *vade mecum* to a young sailor, and being constructed on the catechism model can be committed to memory as such elementary lesson books should be.

Two valuable works appeared in 1875: the one a Manual of the Natural History of the Northern Regions, with instructions for the use of the Arctic Expedition under Captain Nares of the *Challenger*, who had been honoured with a commission from the Admiralty. And the other—A Selection of Papers on Arctic Geography and Ethnology, by the Royal Geographical Society, having the same object.

The instructions in Part I. refer to—1, Astronomy; 2, Terrestrial Magnetism; 3, Meteorology; 4, Atmospheric Electricity; 5, Optics; Tyndall's Hints Towards Observations. And in Part II.—On Collecting Specimens; on Botany; on Geology and Mineralogy. Never had so elaborate a preparation been attempted, and therefore there had never been an expedition occupying anything approaching the responsibility attached to the officers and sciencists concerned. We have yet to learn much of the results, but of what has been made public we will attempt a summary.

Dr. Houghton set out the knowledge already acquired about tides, showed the importance of augmenting it; and we have no doubt that when further observations are reported it will be manifest that if there be a volume of water uncongealed through which we shall ultimately reach the North Pole, the mysterious gulf stream will be the pathway revealing wonders concerning meteorology and magnetism that surpass all our anticipations. The law of tides will be found, like all other laws, to include exceptions, and the exception is likely to prove an absolute contrast. The Willoughby, Franklin, and Russian explorations all point to that conclusion. The conflict of tides indicates chronic convulsion, that when understood will assist us in discovering what is now only surmised—the existence of a positive law acting by dynamics and evolving results that can be reduced to formula. These results can scarcely be aided by the brave toil of Nares and his companions; for until the northern shore of Greenland is surveyed we cannot expect to press on eastward, because it is of the utmost importance that a base of operations is secured. When that basis is gained we believe the further research will not involve the terrible physical endurance which Arctic labour has hitherto required. What one feels is that while it is highly important to obtain hourly observations as we proceed, it is vastly more profitable to push on to localities where unknown phenomena abound, and there to spend effort in meteorological statistics; for in so cardinal a matter as Polar discovery human energy will be better employed in discarding what is in a general sense usual, and taking note only when what is unusual has been approached, and not be taking minute notes until that condition is obvious.

The instructions under the title Magnetism are necessarily vague. Remarks on the importance of acquiring knowledge on this subject from observations in the Arctic Regions are at least a hundred years old. Sabine did more than any one else, and deserves more credit than he has had. From his observations many of the best instruments at our command have been invented. All the instruments which the science of modern mechanics has been able to produce were sent out with this expedition, and in due time their utility will be decided by results obtained on board the *Alert* and *Discovery*, or the sledging parties; very much of the future confidence of England in Arctic expeditions will depend on the completeness of the information acquired by their use, and there is no question that public disappointment will be great if from all these agencies nothing has been gained.

In the important subject of Meteorology there were very specific instructions. It is laid down *that in all cases quality of observations is of much greater importance than quantity*, so that if it be impossible to give *correct* hourly observations two or four-hourly readings should be made. Barometers of two kinds were prescribed, and mercurial to be the only ones for regular observations; when aneroids were employed in exploring expeditions they must be retested by the mercurial, and all comparisons registered.

Then followed still more elaborate instructions upon Atmospheric Electricity, as to be observed by the aid of Sir W. Thomson's portable electrometer, which has been seen by the greater part of our readers at the South Kensington Loan Collection, and is of the utmost accuracy and delicacy.

We shall be anxious to know the issue of Mr. Stokes' suggestions, and Mr. Lockyer's instructions, concerning Spectroscopic Observations; because, although Sir Edward Sabine witnessed most wonderful phenomena in connection with the aurora, he had no instruments adapted for an investigation into the facts and laws thereon.

Then, not to weary the reader, there were specific notes by Dr. Rae, who is a well-known Arctic traveller, about the presence or absence of salt in ice. This line of inquiry and fact-collection has a wide bearing—much wider than it seems. Whether frost drives out salt, and what are the processes which render some ice good drinking, and whether the rotten ice in the crooked channels of this and fifty other expeditions is a sample of what abounds in the region between Greenland (north) and Spitzbergen, and what if any is the action of latent heat; all these must come into the public gaze, and be subjected to the process of crude discussion. The subject itself is within the range of natural observers, and these will aid by their knowledge the theories and chroniclings of science. The last of the scientific hints are from Dr. Tyndall; in which he desires the travellers to supplement the labours of Captain Scoresby, by registering what they could on the form of snow crystals, and all their conditions and forms; then on crystals formed in salt frozen water at given depths, the height of the tallest icebergs and the nature of the moraine matter; the ice strata, the colour of ice, the colour of sky, and the variations ascertained by instruments specially formed. To these he added speculative suggestions, and a copy of several papers on Sound Ice and Forms of Water.

We have then Dr. Hooker on Botany in reference to the Arctic Regions—a most interesting field, both for collection and observation. The preservation of vitality in regions of intense cold, the variety of flowering plants, mosses, lichens, fungi, algæ, and the temperature they are in under snow, with a revelation of a million of facts appertaining to these cognate subjects and their branches, need a separate article for their elucidation, or even notice. The same may be said of geology, so well defined in the instruction of Ramsay and Evans. All this well-timed and carefully prepared labour is the seed; and the logs of the *Alert* and *Discovery* will give the harvest. Professor Maskelyne finishes the series by instructions for observing and collecting mineralogical specimens, in which he commends G. Poulett Scrope's book on Volcanoes, and adds his own invaluable observations on a subject he is the best qualified of all men to discuss.

The nation ordered an outfit at an expense of £120,000, and such instruments and skilled men of science needful to equip two vessels, the *Alert* and the *Discovery*. These were speedily prepared, and a crew, selected chiefly from Dundee whalers, made up, the object being to explore the unknown region round the North Pole by the best route that could afford a base—this was suggested to be *via* Smith's Sound—the conditions of land and sea were to be investigated and described according to the instructions given above.

To attain these results, Commander Markham and Lieutenant Parr went with their gallant crews and reached a higher latitude than had been attained even by Sir Edward Parry. His was 82·45 degrees, theirs 83·20 degrees. His was in 1827, theirs in 1875. Parry took his ship to 81·5 degrees, the *Alert* reached 82·20 degrees, but then it was a steamer and a large one, while Parry's was only a sailing vessel.

The expedition claims to have defined "the character of the great Polar Ocean," and to supply "most important observations relating to the science of hydrography." To have "discovered and explored a coast-line extending for 50 degrees longitude along the Polar Ocean," and to have "ascertained the geology of the whole undiscovered region, as well as of the country from Cape Isabella to Cape Union," besides making "large collections of fossils and rocks." Coal extends "at least as far as 81·44 degrees; coral further north; and the expedition brings evidence respecting the rise of the land in those regions, which will contribute to "the explanation of Arctic geological phenomena." They bring home a collection of fauna and flora of this new land; "and careful observations have been recorded on the migrations and distributions of animal life." In 83·20 degrees, Markham gathered crustaceans at a depth of 70 fathoms; and from this combination of scientific men there is stated to be "a series of meteorological, tidal, magnetic, and electric observations most complete," and also "observations taken for spectrum analysis." "The pendulum observations were rendered useless by the effect of cold on the clock." "The accurate delineation of coast lines in the long channel, from Smith's Sound to the Polar Ocean, and along the northern coasts of Grant Land and Greenland, make most important additions to geographical knowledge."

The *Practical Magazine* must of course wait the due investigation of these matters until the several departments of science have in their free discussion meetings tested the claimed results, and all the lovers of English enterprise and English scientific enthusiasm, wish most earnestly to see the splendid results foreshadowed by Mr. Markham's description. These will, we have no doubt, enhance the reputation of Captain Nares as a prudent and able explorer.

Captain Nares received on his return the thanks of Her Majesty and a knighthood, according to the precedents of former voyagers; his companions also obtained their deserved recognition conveyed by advancement in rank. The enthusiasm at their landing at Portsmouth had its prompt repetition in the City; and at the meeting of the Geographical Society, on Tuesday the 12th ult., Sir George Nares read a scientific paper of very great interest on "The North Circumpolar Sea." In that he distinctly says that he does not pretend to state new facts, or start new theories. Had not his power been crippled by the physical disability of his crew and staff, the knowledge acquired by his southern surveys and his general oceanic experience would unquestionably have enabled him "to state new facts and start new theories," and of this he gave sufficient proof in the comprehensive remarks he uttered on the question of all questions in this department of human search—the existence and source of hea-tcurrents on the seas. He recapitulates the evidence, so positive, of the existence of an enormous heat-generating force, which is manifested by what we call trade winds. He would, if successful on the eastern side of Greenland and beyond Spitzbergen, in some future expedition, perhaps make into a certainty that beyond 80 degrees there is a channel that the farther it is pierced the warmer it gets; a channel, or rather current, not yet ascertained. He makes it quite plain that among the straits and creeks which belong to the north-west passage explorations no such enormous current can be looked for; that the idea is impracticable, and experience has taught its utter unreasonableness. But he half suggests the positive existence of a vast irrepressible supply of hot water communicating between the Arctic and Antarctic Poles, and producing those atmospheric changes which are at once the puzzle of science, the aid to navigation, and the purification of the breathing nourishment of man. These seem to us to be among his articles of prevision, and in regard of which he would be willing to be more positive had he the justification which a more extended term might have furnished, and for which his high administrative, practical, and speculative nature qualify him.

We much doubt whether either of the subjects prescribed in Arctic instructions have any value in contrast to this. Comparisons are not pleasant, because all of us have our favourite subjects, and these claim very properly a kind of idolatry from all who pretend to the virtue of enthusiasm. Electricity, magnetism, meteorology, hydrology, and indeed—more than may at once be recognised—geology, are really waiting for the solution of their several difficulties upon the settlement of the question—whence comes this enormous heat which can affect the temperature of a thousand feet of sea from one end of the globe to the other; and it will abundantly reward any nation, or rather people, to make certain this most mysterious phenomenon. The Arctic Expedition, and the suggestive remarks at the Geographical Society's meeting, will stand most memorable, if such a direction be given to future exploration as shall succeed in ascertaining what is the will and what the way of the Deity in the administration of benefits to his creatures of such beneficent influences as sea, wind, and temperature confer.

In any case, so far as science is concerned, Sir George Nares deserves and receives the just tribute of public approval for prudence, intelligence, and unswerving fidelity amid enormous difficulties. He may not have accomplished so much as Parry and others, but he has been a worthy follower. He could not do again what was done, but he has added thereto.

CLIMBING A STANDPIPE.

WE quote from the Journal of the Franklin Institute the following description of a device used for climbing to the top of a Standpipe in Philadelphia:—

"Some reparations having become necessary upon the standpipe at Spring Garden Station of the Philadelphia Water Works, amongst which the scraping and painting of the exterior, which had become weather-worn and rusted, was the most considerable task, the first step to be taken was obviously to construct a scaffold for the workmen; and, as no means had been provided for the attachment at the top of the pipe of the blocks and falls from which a scaffold should be

GEMS OF ART WORKMANSHIP.—TARRA IN SILVER AND CRYSTAL.

suspended, the climbing of the pipe for this purpose was an undertaking which preceded all others.

"This climbing was accomplished by Mr. George Robinson (a working rigger of this city) in the following way :—

"The standpipe itself is 127 feet of wrought iron shaft, above a square stone plinth, the shaft being about 6 feet in diameter at the bottom, and 4½ feet in diameter at the top (under the cap, or head, ornament, which projects 12 or 16 inches all round).

"At the foot of the plinth, a light ladder, 30 feet long, was set up, with the top to rest against the shaft. Climbing the ladder to the top, carrying a bow or ring of ½ inch round iron rod, which was made to surround the shaft loosely, with the ends about 16 inches long, turned downwards, these ends were lashed fast to each side of the ladder. Next, a piece of rope (3 inch = 1 inch diameter), with an eye in one end, was passed also around the shaft, and was lifted to the top of the ladder, below the ring of iron, when the plain end of the rope was drawn through the eye and made fast, so that the rope formed a 'lashing,' and encompassed the shaft tightly. A single block was now hooked on to this lashing, and the end of the fall passed down between the ladder and the shaft, was made fast to the lower round of the ladder, and the ladder itself then hauled up to the lashing ; and with its upper end steadied by the ring of iron, was placed vertically against the side of the shaft. Another ring of ½ inch iron was placed around the shaft at the bottom of the ladder, which ring was also lashed to the sides of the ladder, and steadied the bottom whenever it was attempted to lift by the lower round. The ladder being elevated as described, and held in place by making the hauling side of the fall fast to something below, another lashing like the first one, was taken to the top of the ladder (in point of fact, Robinson stood upon the top of the ladder each time it was hauled up, and took with him this second rope) ; and this rope was then converted into a second lashing like the first one, only about 25 feet higher up on the shaft.

"A second block was hooked into this second lashing, and the end of a fall from it was taken down behind the ladder to the lower round, and made fast, while the other end was hauled tight to relieve fall number one. Lashing number one was now cast off, and taken to the top of the ladder, and by means of the second fall the ladder, with Robinson upon it, was lifted to the second lashing. At this point the operation merely repeated itself, except that, from the reduced diameter of the shaft, it was necessary to bring the head of the ladder up to the lashing and make new ends, to the top bow of iron (which could be bent cold) twice in the whole climbing. The bottom ring it was not found necessary to reduce in dimension. Five fleats brought Robinson to the top of the shaft, and as the top of the ladder was then hung far enough from it, he was able to pass at once over the projection of the cap, and mount upon the plates which covered this projection (a low ornamental railing surrounds the cap). Having reached the top, the other attachments became easy. The man Robinson, and another rigger to handle the rope, aided by one or two men, when a pull was required, performed alone all the labours of the task. They came to the Spring Garden Works at about 10 A.M. ; and in less than two hours (before 12 M.) the column had been climbed, and the ladder was sent down."

NEEDLE MAKING AT REDDITCH.

REDDITCH, in Worcestershire, and Aix-la-Chapelle, in Germany, may be regarded as the seats of the needle-trade of the whole world, comparatively few needles being made elsewhere ; English needles are, however, more in request than those of any other country. As the needles undergo a considerable number of processes, from the rough steel wire to the highly-polished hand instrument, which is not yet superseded by its machine competitor, perhaps some account of their manufacture may not be found uninteresting.

The steel wire, which must be of excellent quality, being hand-drawn for best needles, is first cut into lengths capable of making two needles each. This operation is performed either in bundles by means of hand-shears, or four at a time in self-acting machines, the shears of which are worked by an eccentric while the wire is fed up to them. The two-length pieces of wire are then formed in bundles of from three to five inches in diameter, according to the size of the wire, and held together loosely by a pair of iron rings, in which state they are annealed in a furnace heated by a wood fire. When sufficiently soft, the wires, still in bundles, are rolled one over another by the aid of what is termed the smooth file, and thus made to straighten each other.

The next operation, that of pointing on grindstones, formerly involved greater loss of life than any other industrial occupation. The needles (twenty-five at a time) were made to rotate against the stone between the fingers and thumb of the operator ; and the subtle dust from the stone and the needles was inhaled with the breath, and found its way into the lungs, causing the malady known as grinders' asthma, to which all grinders succumbed at an early age. All this is now changed however. The needles are made to rotate between two indiarubber bands travelling over the concave face of the grindstone, of special quality obtained from Frankfort ; and the fine dust is carried off through a channel under the grinder's seat by an exhausting fan, which does duty for all the stones.

The middle portions of the wires, now pointed at both ends, are next brought under a falling die, worked by the foot, which stamps the gutter for the eye, roughs out the heads, and marks the position of the eyes. The flattened portion has become hardened by the blow, and this hardness has to be removed in the annealing oven. The holes for the eyes are then punched out by a pair of small punches in a hand screw-press ; these punches require careful workmanship both in making and adjusting, and employ special operatives, who work with magnifying glasses like those of watchmakers. A number of the pairs of needles, still united, are then threaded, or "spitted," as the term is, on a pair of fine wires ; and the burr or fin, made in stamping the heads, is then removed by a file. After the lengths have been divided by bending the wires backwards and forwards between the two spits, the rudely-formed needles, now for the first time separate, have their heads rounded off by filing, especial care being taken to avoid weakening the eyes.

The needles are next heated in small iron trays, and then dropped separately into cold oil, which makes them very hard ; they are then tempered by being heated on a hot plate, or in a charcoal stove, until a dark blue film forms over them. These two operations cause some amount of warping, to counteract which the needles are straightened by hand-hammers on small anvils. To ascertain if they are straight, the needles are rolled by the finger on a smooth steel plate, and such as do not run smoothly are again straightened with the hammer

The next operation is scouring to remove the black coating, and give the needle that high polish which is necessary to enable it to pass readily through the fabric. Formerly, from seven to eight days were occupied in the case of best needles by this one process ; but now the time is considerably shortened, owing to improvements in the appliances. The needles are weighed out into lots of from 400,000 to 500,000 each, according to size, and tied up with emery powder, oil, and soft soap, in a square piece of strong canvas, and securely bound with cord, thus forming rolls or bundles about two feet long and three inches in diameter. These bundles are rolled backwards and forwards in the scouring machine under a heavily-weighted slab, worked by cranks, driven by the engine. This process is repeated from seven to eight times, according to the quality of the needles, the needles being washed in soapsuds after each scouring. The final polishing is accomplished in the same manner, but with putty powder, and the needles are then dried in ash-wood sawdust.

The needles are now highly polished and well-tempered, but with the eyes not yet perfect. The heads are all arranged in the same direction by gradually bringing them up to the edge of a board, and letting the heavier heads fall over, so that they may be taken up and turned the other way ; this is done by means of a couple of metal plates, as touching the needles by the hand would cause them to rust. For picking out defective needles, which must be done by hand, an operative of the gentler sex is chosen whose hand is cold and dry. Before the eyes are drilled they are softened or "blued" by being made to pass through a gas flame by means of a revolving wheel, which picks them up by an ingenious arrangement. This seems to be the only process where any inconvenience is felt by the operatives, who complain of headache after remaining for any length of time in the room where several of these gas flames are burning ; but the withdrawal of the fumes from the gas by a hood and exhausting fan, like that used for the grindstones, would obviate this inconvenience. The eyes of the "drilled-eyed" needles are smoothed by a fine counter-sunk drill of delicate workmanship, several drills being driven by one pulley. The eyes are polished by being again "spitted" on wires smeared with emery and oil, and hung in a frame made to travel backwards and forwards by the engine. As the wires are stretched in a direction oblique to the line of motion, the needles are shaken about in different directions so as to effectually round out the eye. Both heads and points are finished on small grindstones of very fine texture, a number of needles being rolled together between the

finger and thumb, then polished in the same manner on emery buff rollers.

After passing through these multifarious operations the needles are at length quite finished, although some extra qualities now have their eyes gilt by the electrotype process; all that remains to be done is to put them up in packets, generally containing a quarter of a hundred, ready for sale. The better kinds are stuck through strips of cloth pasted to the paper; but even with the commoner kinds an improved wrapper has lately been devised, which enables one needle to be selected without the danger of all the rest falling out of the packet. Women and girls are employed in many branches of this interesting manufacture, and do not seem to suffer in health, except in the one instance above mentioned.

SAWS AND SAWING.

By Joshua Rose.

THE difficulties experienced in the use of saws arise from, first, their necessary weakness in proportion to their duty; secondly, the difficulty of disposing sufficiently rapidly of their cuttings, the saw-dust; thirdly, from peculiarities and variations in the nature of wood; fourthly, from the skill required to keep them in proper working order; and fifthly, from the impracticability of tempering them as hard as they should be, if the temper bore the same relation to the material cut, as is the case with most other wood-cutting tools.

The desirability of using thin saws, in order to lose as little timber as possible by keeping the kerf narrow, added to the distance at which the cutting edges of the teeth operate from the end of the saw, in frame saws, and from the centre in circular saws, or in other words, the distance of the cutting points from their driving point, renders the blades very liable to spring; and thus involves a whole train of evils. If the spring was at all times equal in amount, and in one direction, it would be no difficult matter to so shape the teeth as to counteract it; but such is not the case. For in addition to the angles of the teeth, their relative keenness, added to inequalities in the wood itself, form constantly disturbing elements; and it is to suit these varying conditions that the shape of the teeth must be conformed.

Saw teeth may be divided into three classes: cutting teeth, sawing teeth, and intermediates. Cutting teeth perform their functions by paring the wood; sawing teeth act by first cutting a line on each side of the kerf and then removing the unsupported centre by scraping, while the intermediates perform more or less of both these functions.

Cutting saws are applied to slitting or ripping purposes, and sawing ones to cutting across grain; and yet the action of the two is in one respect identical—that is to say, in both instances the teeth sever the fibre of the kerf from the main body of the wood before attempting to entirely dislodge it. The fibre of the wood lies lengthwise of the log, and the cutting edge of the ripping tooth lies at about a right angle to it, so that the edge severs the fibre, and the wedge of the throat face removes it. So likewise in a cross-cut saw, the cutting edge strikes the fibre at a right angle to its length and severs it, on each side of the kerf, from the main body of the log before attempting to dislodge it; hence the difference between the forms of the two is an adaptation to accomplish, in both cases, the same order of operations and results.

In order to clearly understand the principles governing the shapes of teeth, it is necessary to consider the directions in which the strains are placed upon the teeth, and to what manner those directions are influenced by alterations in the angles of the faces whose function forms the cutting edge. Here again we shall find that the shape of these cutting edges, in both the slitting and the cross-cut teeth, are, relative to the duty, as much alike in form as the thickness of the saw blade renders it possible to get them; that is to say in a slitting saw the rake is all in front of the tooth, because the cutting duty is in front; and in the cross-cut, the rake is on the side, because the cutting duty is there also; the advance and cutting edge operating at a right angle to the length of the fibre of the wood.

Suppose fig. 1 to represent the magnified teeth of a common hand saw, and that the front edges of the teeth are bevelled as shown, which is called fleaming, then the strain placed by the duty on that face, being at a right angle to its plane; there will be induced a pressure in the direction shown by the arrows in the edge view, and operating to spring each tooth in the direction of its set; so that if one of the teeth possesses a greater degree of angle or fleam than the others, it will spring more in that direction and perform more duty than the others. As a natural consequence, it will become dull sooner, and, when dulled, will spring away from its duty; that is to say—in a direction to reduce the amount of its set, and induce both friction and heating. Suppose, on the other hand, that in fig. 2 we have a saw with no side angle on the front face of the tooth, there will be in that case no strain tending to spring the tooth sideways, save that due to the set of the teeth, in which respect both forms of teeth are affected. It must be borne in mind, that this cross

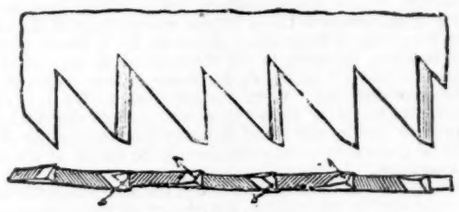


Fig. 1.

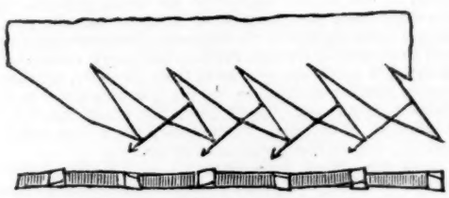


Fig. 2.

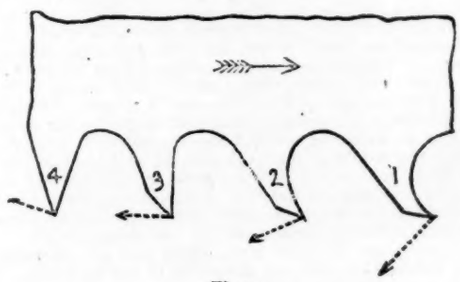


Fig. 3.

angle, or fleam, on the front face, increases with the thickness of the saw-blade; and, conversely, decreases with the thinness of the same; and this it is which, in conjunction with the comparative slowness of the duty, renders it admissible and desirable in most hand saws when it would not be in gangs or thick circular saws. Furthermore, the resistance being less, it is more appropriate for the softer woods and least applicable for hemlock and spruce, the knots of which would, from their hardness, break the teeth, if appreciably weakened by cross angle or rake.

If the front or throat face were given an angle in the direction shown in fig. 2, it would present a very keen edge, rendering the tooth especially liable to spring, and, as a consequence, to break—particularly if it were a long one and used upon hard wood. In a cross-cut saw, the angle of the faces running across the thickness of the teeth, induces a strain sideways; also tending to give the teeth more set, as shown in the edge view at fig. 1. The back face of the tooth must stand at an angle sufficient to give strength and keenness to the cutting edge. In fig. 3, tooth No. 1 has a maximum of front and a minimum of back rake; the latter having no duty to perform, save it be to support the cutting edge and give it sufficient clearance. No. 2, having less front rake, or hook, as it is commonly called, has more back rake, and, as a consequence, the latter enters somewhat more into the element of the keenness of its edge. In No. 3, the front edge having no hook, or rake, the back one has considerable; and in No. 4, the front edge being sloped backwards, the back edge determines to a very great extent the keenness.

It is very apparent to the most casual observer that the form shown at No. 1 is the keenest tooth, and that the cutting edge is well supported by the metal behind it; but its great defect

is, that it receives the strain of the cut in the direction of the arrow, and as a result, when it strikes a knot, it springs deeper into its cut, and therefore breaks off—especially if the tooth is a long one. Tooth No. 2. is less keen, and the edge is not so well supported by the metal behind it; but its reduced liability to spring more than compensates for the difference. No. 3, having its front edge at a right angle to the depth of the cut, has a scraping rather than a cutting edge; and is furthermore considerably weakened by the sharpness of the angle of the back face.

We have now to consider the effect upon these teeth of the set which, in any case, tends to spring them, because the cutting edge is thrown in each case to one side of the blade. If the front edge is fleamed, as shown in fig. 1, the set aids the fleam to spring the teeth in the direction of the set; while if it is square across (as in fig. 2), the strain is less—although still in the same direction. Were any set given to No. 1, in fig. 3, its tendency to spring sideways, as well as into the cut, would cause it to buckle and bend in every direction; while No. 3 might be given ample set, even though the length of the tooth was excessive.

So long then as the teeth are sharp, the set springs the blade in a wave line or corrugation, the amount of which varies with the angle of the front face and the amount of the set. So soon, however, as the outside corner of the tooth gets dull (and it always dulls there first, because it is there that the cutting is done), the tooth springs in the opposite direction; reducing the set and thus causing friction, heating, and rough work; because when the dull tooth springs away from its duty, or when any successive number of teeth do so, the first sharp one performs, in addition to its own proper duty, that which the dull teeth have skipped. This gives to the sharp tooth undue duty and excessive spring in the direction of its set.

It is of the utmost consequence, then, that the setting be performed uniformly. In this connection another and important point must be attended to; and that is, that as the natural tendency of the teeth is, being made straight, to remain so; then when a tooth *is* bent (the convex side of the tooth being stretched and the concave side compressed), the middle of the thickness of the metal resists both the stretching and compression, and retains a tension tending to force the tooth *back* from its set. As a result, a comparatively slight pressure in the proper direction will reduce the amount of the set. To obviate this defect, it is an excellent plan, first, to give to the whole of the teeth an excess of set, and then to reduce it so that the metal in the middle of the tooth shall be given a more permanent set by relieving it of the central tension referred to, or rather by reversing the direction of the resisting tension. The set should be not a straight angle, but a curve, which gives to the cutting corner an element of increased sharpness.

In many cases but little set is given, and the clearance is partly obtained by spreading the points of the teeth. But this is only permissible to a limited extent; because, in the spreading, the grain of the steel is upset, and its strength impaired, causing the points to break off. The degree of hardness of the blade is an element to be, in this connection, considered; for the harder the blade is, the more the strength is destroyed by upsetting, rendering its utility very doubtful for the harder kinds of wood. For the softer kinds, however, upsetting on soft blades is found to be of advantage. To accomplish this spreading a "set" is used; and unless this "set" is held, in each case, in the same relative position to the tooth, the angles and the keenness are varied, and irregular action, spring, and uneven dulling ensues.

We may next consider the length of the teeth, and this depends largely upon the nature of the duty? The longer the tooth, the weaker and more liable it is to spring from any of the causes already enumerated; but at the same time this is, in a great measure, compensated for in the extra freedom given to the dust. It is evident that there must be between the teeth of a saw sufficient space to afford ample room for the amount of dust a tooth will remove at its maximum cut; and if this room cannot be given in length of tooth, it must be allowed in the distance of the teeth one from the other. For use upon hard woods, a shorter tooth, with wider spaces between, is desirable; because, though the dust is finer (and less liable on that account to clog in the teeth), yet the duty is greater, and hence the spring more; and knots are, therefore, more liable to break the teeth. In any event, the teeth should be of an equal height, otherwise the protruding ones are subject to an excess of duty, inducing both spring and breakage; besides reducing the capacity of the saw by diminishing the number of cutting teeth, and rendering their dulling more rapid.

The shape of the throat of the teeth should be either rounding or at least of as obtuse an angle as possible, so as not to hold the dust; and the depth of the throats should be equal, because they regulate the length, and therefore, in a great measure, the strength of the teeth, which is not of so much consequence, so far as regards the resisting the direct strain of the cut, as it is in resisting the tendency to spring sideways, and therefore in altering the amount of the set.

The shape of the throat is of far more importance in short teeth, and in those comparatively close together, than in those long or wider apart. Close teeth are, it is true, better adapted for light duty; because in that case the amount of duty (and hence of dust removed at a cut) being comparatively small, not so much room between the teeth is requisite to accommodate it; and such room may be given in the length of the tooth, unless its front face is much "fleaming," as shown in fig. 1—in which case, unless the feed is light (as in the case of a hard saw) the spring would be excessive.

From these considerations we should arive at a form of tooth approaching that shown in fig. 4, as applicable to gang saws

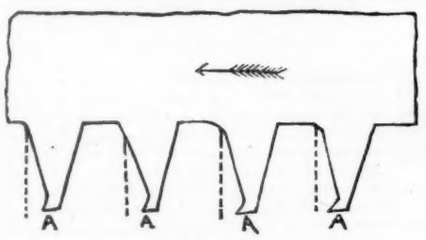


Fig. 4.

for general purposes. The principles upon which this form of tooth is constructed are as follows:—The front face of the tooth is given a slight rake or hook, which may be given by swaging; and the tendency (given by the rake) to spring into the cut is compensated for by the point of the tooth standing back from the front base, as shown by the dotted lines. By reason of the front rake, the edge can be made keen enough without too much angle on the back face at A, A, A, A, in fig. 4; hence the cutting edge is well supported by the metal behind it. It is in fact well sustained; the teeth are sufficiently wide apart and deep to afford ample room for the dust, and the corners near the point of the tooth and at the base (in front) are rounded, so that the dust shall not lodge there. Furthermore, the liability to spring, from the set is, in a great measure, contracted by the cutting edge being pulled instead of being pushed to its cut; and in all cases where spring is a serious defect, pulling is resorted to. Thus in an iron planing machine the tools are often bent back; while in rifle-barrel boring and rifling, pushing is found to be altogether inadmissible. The spring of the body of the blade is, in frame saws, resisted by the tension of the saw in the frame; but this does not prevent the individual teeth from springing from their bases.

In solid circular saws, the principles we have considered have especial importance, because of the liability of the saw to spring sideways. In those having inserted teeth we have another consideration. In a solid saw, the destruction of one or two teeth necessitates the filing down of all the others to the size and radius of the broken ones; and the teeth require to have "set," and if this set is partly obtained by swaging, we have the liability to break and to spring before referred to. By inserting the teeth we may replace the broken by new ones, and may reduce the latter to the size of those uninjured, and thus maintain both the size and velocity of the saw. A greater advantage, however, is that clearance may be given to the teeth, by giving them a spread at and towards the cutting edge; and since this spread is made to extend equally on each side of the thickness of the saw blade, the tendency to spring induced by having the set all on one side (as shown in the edge view at fig. 2), is avoided—providing we file the front face of the teeth square across (as shown in fig. 2), and not fleaming (as shown at fig. 1). To off-sett this, we have two considerations: first, that such set can be maintained only by swaging the teeth, which, as already explained, weakens them; and secondly, such teeth are apt in time to become loosened in their sockets. The first objection can be removed only by a resort already being put into practice, and that is by separating the cutting part of the teeth from the shank, and thus composing the inserted teeth of a shank and a bit, so that the bit may be taken out and ground up, say three times, giving it four runs, by which time its clearance will, it is true, be worn away, but the inexpensiveness of providing the bits, compared to having to replace the whole tooth and shank, will make the operation desirable. Furthermore, the second set of bits may be made

a trifle larger than the first, to take up any wear that may have taken place in the sockets.

To still further remedy the second objection, the teeth should be made as narrow as is consistent with clearance; which will not only reduce the width of the kerf, and thus save timber, but by reducing the amount of the duty, will correspondingly diminish the strain on the socket. Another advantage possessed by this plan, is that the teeth may be tempered to a harder degree; for good steel tempered to a blue, will not stand swaging without having the strength almost destroyed; and hence teeth depending upon swaging for their clearance are left too soft. Another inducement to have the blade soft is to facilitate the filing; but this is obviated when (the teeth, being inserted bits only, and intended to be sharpened but three times) the amount of filing is reduced to a minimum, and may, from the shape of the bits, be dispensed with altogether by the substitution of an emery wheel. An objection to any form of inserted teeth is that the shank depends upon the spring of the socket to hold it in place; but this defect is more than compensated for in the gain due to having the tooth spread on both sides of the thickness of the blade, instead of having set on one side only. Furthermore, the blade may be finished with false shanks and teeth placed in the sockets, thus allowing for the spring.

The main advantage of the circular saw is in the ease with which it may be operated, and the high rate of speed at which it may be run. But to off-set this, it requires continuous attendance; since the work is performed so rapidly as to be in the operator's hands nearly all the time, chisel teeth require a large amount of clearance in the throat to give room for the dust; because, from their shapes, the teeth possess all the obtainable advantages, inasmuch as the hook (and hence the keenness) may be greater than is possible in frame saws; and furthermore, the angle of the back face may be less, and the cutting edge is, as a result, better supported by the metal behind it. Hence they take a coarser feed, and have more dust to dispose of. Taking all these things into consideration, and not omitting the fact that circular saws, save for edges, cannot be used in gangs, there appears no reason why the future is not full of promise for inserted teeth circular saws.

We may now turn our attention to band sawing; and here again the principles governing the shapes of the teeth are the same; but we have other considerations claiming attention. For fine small work, the band saw already stands unrivalled. The obstacles which have so far prevented its general application to large work are: first, it requires much skill to operate; secondly, it is difficult, where the depth of the cut is great, to give the teeth sufficient throat to provide dust room; and as a result, it packs between the teeth, which in turn packs the dust firmly to the sides of the kerf. A third disadvantage lies in that the tension of the blades must be kept even; and is liable to vary even from alterations in the temperature. On the other hand, the speed of a band saw may be as great as or greater than that of circular saws; and the thickness of the blade may be reduced to nearly one half that of the circular, which involves a considerable saving in power, as well as in material. The clearance may be assisted by placing the teeth wider apart; the rate of duty being maintained by a commensurate increase of speed. In short, there appears no reason why the band saw should not be more generally adopted, providing it is made and used with sufficient care. This remark applies equally to circular saws; the difference being in favour of the latter, only in that it may be made and used with less skill. Indeed, our remarks will disclose, all through, that a great deal more depends in all cases upon exactitude, both in the form and in the dressing of the teeth, than in the particular method of sawing; and it would therefore appear that, as our experience with both circular and band saws increases, they must continue to make inroads upon the present position held by frame saws, because of the relative greater capacity of the two former, notwithstanding the increase of cost due to their requiring continuous attendance by the operatives. For the increase of duty is greater in proportion to the total expenses, than is the increase of wages in proportion to the duty performed.—*The Polytechnic Review, (American.)*

OSCILLATING PUMP.

THE accompanying engravings represent a new form of oscillating pump, the novelty of which consists in the use of a section of a hollow cylinder, oscillating on its longitudinal axis, in connection with a stationary packing and suitably arranged valves. By this construction it is claimed that increased efficiency of working parts is obtained, and that the usual boring out and much of the necessary fitting, incident to pumps of this class, are dispensed with.

Fig. 1

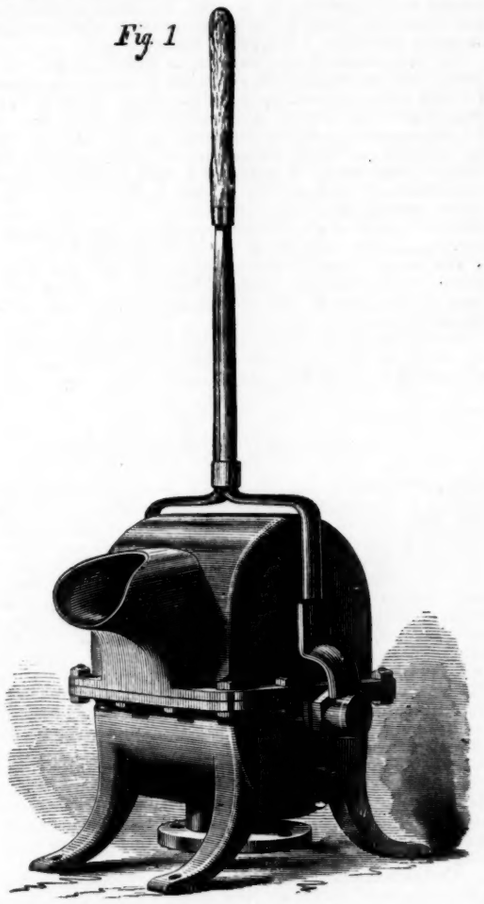
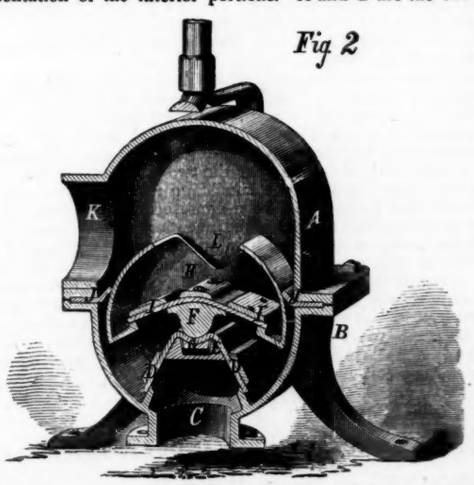


Fig. 1 affords a perspective view of the device, and Fig. 2, a representation of the interior portions. A and B are the two

Fig. 2



sections of the shell or outer casing, each provided with a flange and bolted together to form an oblong cylinder with closed ends. C is the induction chamber, in which are valves opening upwards. The leather forming these valves is in one piece, passing over the abutment, E, thereby packing the joint between

it and the shaft, F. G is a plate supported on springs in a groove in the abutment and serves to hold the leather in close contact with the shaft. H is a sectional hollow cylinder connected to the shaft, F, by plates through which are ports, closed by the valves, I I, opening upwards.

The joint between the sections, A and B, is packed with leather, the inner edges of which are turned up as shown at J J, and, resting against the periphery of the cylinder, H, serve also as packing between said cylinder and the casing. K is the discharge opening leading from the air chamber formed by the upper portion of the section, A. The outer ends of the shaft, F, are squared to receive a handle, as shown, by which the cylinder, H, is caused to oscillate in its bearings. By this means, through the action of the valves, I I, the water is drawn into the interior of the cylinder, whence it passes through the opening, L, and finally escapes from the discharge, K.

The invention, as is evident from the illustration, is very simple in construction. The cylinder, H, is turned off with great facility, and as the two sections of the case are cast separately, each in a single piece, little is required beyond attaching the lower valves and bolting the flanges together. By removing the top section, the entire working parts are exposed for examination and repair.—*Scientific American.*

THE FAC-SIMILE TELEGRAPH.

THERE was in operation between the Signal Service section of the Centennial Exhibition and the Chief Signal Office at Washington, on a circuit about 150 miles long, an instrument which transmits by telegraph the weather maps of the Signal Service, heretofore produced only in Washington. These maps contain what are called the isobaric lines, or lines running through the points of equal barometric pressure; and they show as well the different areas of the country. It has hitherto been impossible to present these maps to the public, owing to the inability of the ordinary telegraph to transmit anything but words and figures. This invention reproduces the map entire, with its lines and figures. It is then lithographed and printed for distribution on the presses with which the Signal Office is supplied.

The method may be briefly described as follows:—The map, or message, to be sent, is first written upon ordinary paper with ink in which a little glycerin has been mixed; then before the ink is dry it is sprinkled with some powdered shellac, which adheres to the ink. The manuscript is then passed between rollers with the face against a piece of hot zinc. The latter takes up the shellac, and a negative is produced in shellac, the best non-conductor of electricity, upon zinc, a good conductor. This plate is then bent around a cylinder which is rapidly revolved, while a metallic point connected with the conducting wire is held to its surface by a spring and makes a spiral line over the face of the cylinder. At the receiving instrument a similar point traverses the face of a similar cylinder upon which is placed a piece of chemically prepared paper.

As the transmitting point comes to the line of writing the receiving point makes a dot on the paper by decomposing the chemically prepared paper, and as every portion of the writing is touched by the transmitting point, the result will be a *fac simile* of the original writing or device. To produce this result it is necessary, of course, that the two cylinders should revolve exactly together, as if one should go faster than the other the discoloured paper would be a confused mass of dots. In this consists the great novelty of the invention. Isochronous motion of the cylinders is secured by a magnet at the receiving station, which at each revolution of the transmitting cylinder accelerates it, if too slow, or retards it if too fast. It is believed that this invention will prove a valuable adjunct to the present systems of telegraphy, or may, with further improvement, supersede them. The inventors are William Edward Sawyer, of New York City, and James G. Smith, of Hackensack, New Jersey.—*American Manufacturer, Nov.* 24, 1876.

A NEW MANUFACTURING INDUSTRY IN AMERICA.

WE quote from the *Western Manufacturer* (American) the following paragraph, showing that our cousins are eager to cultivate home industries more and more, and endeavouring to compete with foreign manufactures and importations.

"We do not know of a manufacturing industry that holds out so fair a promise of profit and permanency to the careful and cautious investor at the present time as the linen manufacture. It is an industry that is almost new to this country, and the skill and machinery that might be turned into this channel could easily be made remunerative. Nearly every other branch of manufacture in the textile as well as the iron industries, if not overdone, is already worked fully up to the point of safe investment, and competition with the foreign manufacturer has long ceased to be a factor in the problem of profits. A far closer and fiercer competition is now waged between domestic manufacturers themselves. In the linen industry there would be little or no competition, except with the imported article. Last year we imported about fourteen and a half million dollars' worth of linen goods, which was two millions less than that of the year preceding. The falling off, of course, was not on account of any home supply, but simply that the hard times compelled people to economise and retrench.

"Some enterprising parties have recently commenced the manufacture of linen on a small scale in Manchester N. H., which promises to be a permanent success, and to grow into a large establishment. The company sewed the flax, gathered the crop and prepared it for spinning. The outlay was small, and if the enterprise had not proved successful there would have been but a trifling loss. The field is open to the enterprise and skill of any man or company of men who may wish to invest capital in the most promising industry of the day. The flax is already cultivated to a considerable extent in many places mainly for the seed, while the straw is left to waste, or is used in its most crude and least valuable form. Let linen manufactories be established in different localities in the West, and the raw material would be furnished in abundance at a merely nominal cost. We cannot too strongly urge practical men looking for investment in some industrial enterprise to look into the merits of this new industry, and not only save to the country a portion of this fifteen millions of dollars now annually sent abroad for the product of linen workers, but turn the profit of its manufacture into their own pockets."

THE METRIC SYSTEM.

THE Boston Society of Civil Engineers having recently requested the co-operation of Franklin Institute in petitioning Congress to fix a date after which the metric weights and measures should become the only legal standards in the United States, the Institute appointed a committee to report on the subject. The report gives a history of the introduction of the system into France, and also shows the many and grave inconveniences of introducing a new system into the United States, as counterbalancing the advantages resulting from its introduction,—all of the arguments applying with equal force to this country,—that we have given it in full.

There is much to be said on the other side of the question, and we think that the question of the expense consequent on the change in the machine shops is much exaggerated. Putting aside the question of domestic inconvenience, there is no doubt that, in the growing commercial relations of the different parts of the world, it would be a welcome change if all the measures and monies were expressed in the same terms, and conveyed the same meaning.

The report says:—

"The subject of weights and measures, which are *the instruments used in weighing and measuring*, has received the attention of all governments, and always with a desire to promote uniformity. The literature of the subject is copious.

"Your committee will not repeat it, except so far as may enable us to determine the propriety of the proposed action. They refer to the admirable report of John Quincy Adams, Secretary of State, made to congress February 22, 1821, and to the reports of the Board of Managers of the Franklin Institute, made to the legislature in this state in 1834, published in the Journal of that year, for the history of the subject, and to the various encyclopedias for information as to the present state of metrology in France.

"We are invited to adopt the system of France and to compel our people to use it. With her example before us as a guide, we may contrast with our own:—

"1. The condition of the weights and measures of France before her revolution.

"2. The opportunity presented by the times when the French undertook their change.

"3. The character and habits of the French government and people.

"4. The system as originally designed by the French commission and as ordained by law.

"5. The passive resistance of the people to the changes, the entire rejection and abolition of parts of the system (including all compulsory provisions), the compromise of 1812 in the adoption of the *système usuel*, in combination with the decimal metrical system originally forced upon the people, and the final establishment of this system in 1840.

"6. The reasons for this resistance and reaction. And then, after a consideration of the immense number of fixed and recorded measurements now existing in this country, and of the expense, labour, and confusion which the attempt to change them would occasion, we shall perhaps be able to form an opinion as to the wisdom of such an attempt:—

"1. The condition of the weights and measures in France when the Bishop of Autun proposed a reform, may be described as legal confusion. In the memoir of the Bishop (afterwards Prince de Talleyrand) he enumerates 13 different lengths of the foot (*Pied*) in legal use, measuring from 120 to 150½ *lignes;* 18 different legal yards (*Aunes*) measuring 299$\frac{88}{100}$ to 597$\frac{88}{100}$ *lignes;* 21 different legal pounds (*Poids de Marc*) weighing 6479 to 9767 grains; 24 legal *Boisseaux*, containing from 128 to 5157 cu. in.; 17 legal *sacs*, containing 3584 to 7349 cu. in.; 23 legal *septiers*, containing from 924 to 10,830 cu. in.; 13 legal *Tonneaux*, containing from 12,203 to 97,989 cu. in., besides others, and adds, 'this table is only a much abridged extract of the principal differences between the weights and measures of the kingdom.'

"The situation in France invited reform. There is no such diversity here. The weights and measures are by law, uniform throughout the United States, although slight diversity may exist in fact. The same motive for change does not exist here as existed in France.

"2. The opportunity presented to France was peculiarly favourable for a change. The new system was struck out during the red heat of the revolution, during which the king was dethroned and beheaded, the nobles were killed wherever found, and their property, when they fled for their lives, was plundered or confiscated. The priests were driven from their cures, and religion was abolished. The Christian era disappeared and the world began again at the year one of the French Republic, upon the 22d of September, 1792, 'the day of the autumnal equinox, when the sun entered the sign of the balance, the symbol of equality.'

"However, favourable to the introduction of a perfect system of weights and measures, your committee hope that no such opportunity may be presented in this country.

"3. The government of France has always been in the habit of interfering with the private affairs of the people. For instance, the prices of butchers' meat and of bread are fixed by the prefects of police. A journeyman may not engage with a master mechanic without the permission of the same officers, &c., &c. The people are accustomed to this parental care, and would feel lost if it were withdrawn. They will, if necessary, rise up and destroy the government, but while it *is* the government, they are accustomed to feel its hand in their private affairs. A law, which proposed to abolish the old weights and measures in use, and the old habits of the people in weighing, measuring, and trading, and to substitute new ones with new names, would be more likely to be obeyed when enacted by the government of France than by that of the United States.

"This government is authorised by the constitution to 'fix the standard of weights and measures.' It would be questioned whether this power 'to fix,' meant to change, to abolish, and to substitute new and foreign weights and measures. Our general government has never undertaken to enforce the laws to maintain the existing standards. The supervision of the subject has always been the care of the separate States. A law of the United States, such as proposed, would probably be a dead letter unless enforced by means which the people would not submit to. The American idea of government duties is, that it should do and enforce justice, and that liberty in all things innocent is the birthright of the citizen.

"4. The system established by the French, and the difficulties of the undertaking, may best be understood from a brief chronological sketch.

"In 1790, Talleyrand addressed a memoir to the constituent assembly, setting forth the condition of the existing metrology and proposing to establish a new system for all France, whose primary unit should be the length of a pendulum beating seconds, as a natural standard. His proposition did not embrace a decimal system.

"A decree, adopting the proposition, but with serious modifications, was sanctioned by the king, Louis XVI., upon the 22d of August, 1790.

"In execution of this decree, a committee of the Academy of Sciences was appointed to examine and report upon the subject. The report was made August 19, 1791. It proposed the ten millionth part of a quadrant of the meridian as a natural standard unit of lineal measure to be applied as a measure of matter in its three modes of extension, length, surface and solidity; and as a secondary standard of comparison with this unit, the length of a pendulum vibrating one hundred thousand beats a day. The weight of distilled water contained by a cubical vessel in decimal proportions to the lineal measure, was to be the standard unit of weight. The whole system of weights and measures was to be composed of multiples and subdivisions of these units according to the decimal system. The report recommended that the quadrant of the arc of the meridian should be divided into 100 degrees instead of 90, as before. The decimal division of time also was part of this plan.

"To carry this plan into effect it was necessary, with the utmost accuracy, to measure the arc of the meridian, to weigh the ascertained bulk of water, and to find by experiment, the length of the pendulum beating 100,000 seconds per day. The report being sanctioned, the execution of the scientific observations was immediately begun, but was not completed before seven years, owing to numerous interruptions, occasioned by the overthrow of the government and the abolition of the Academy of Sciences.

"Upon the 5th of October, 1792, the new calendar was established by law. It made 100 seconds in a minute, 100 minutes in the hour, 10 hours in a day, 10 days in a week, 3 weeks in a month, and 12 months in a year. Thus 100,000, seconds made a day, 30 days made a month, and 360 days a year. The five or six odd days in the natural year, having no month to cover them, were called in derision *Sans Culottides*, or, days without breeches, and were devoted to games and frolics.

"The quadrant of the circle was also divided decimally into 10 parts, and each part into 10 degrees. The quadrant of the meridian containing 100 degrees of 100,000 *metres* each, was to be 10,000,000 *metres*, and the circumference of the earth forty millions of *metres* in length.

"The universe, under this system, might be compared to a great French clock, having the earth for its escape wheel, whose equatorial motion would be 400 *metres* per second.

"The National Assembly, impatient at the delay in establishing the definitive *metre*, decreed upon the 1st of August, 1793, that the system should go into operation immediately, based upon a measurement of a degree of the meridian made in 1740, which made the length of the *metre* 443$\frac{44}{100}$ *lignes* of the ancient French foot. This decree adopted a complete nomenclature of all weights and measures for lines, surfaces, and solids. The length of the *metre*, and values of all measures derived from it, were to be provisional and lawful until the final determination of the correct figures. The new nomenclature and the use of 100,000 seconds per day, were made compulsory by the law of 24th November, 1793.

"By the law of 7th April, 1795, some of the names were changed, and the existing nomenclature of the French metrology was *definitively* established, although the sizes of the weights and measures were *provisional* only. This law provided that the weights and measures might be made of the units, ten units, the double units, half units, and tenth units, but no other multiple or subdivision, such as ⅓, ¼, ⅙, ⅛, should be made or used. The same law re-established the scientific commission for the work of determining the definitive *metre*, &c., and repealed so much of the law of 24th November, 1793, as obliged people to use 100,000 seconds in a day.

"The arc of the meridian between Dunkirk and Barcelona was measured by Messrs. Delambre and Mechain, with great accuracy. It comprehended about 9⅝ degrees of latitude. The measurement was continued south by Messrs. Borda and Biot to the island of Formentara, so as to comprehend 12 degrees of latitude, of which, 6 were south of the 45th parallel, and 6 north of it.

"The degrees of latitude were found to be of different lengths and the differences followed no law. An average was therefore taken, and then the length of the *metre* was determined to be 443$\frac{296}{1000}$ *lignes* of the old French foot (being $\frac{1}{750}$ of an inch less than the provisional *metre*) and equal, according to the measurements of the French Academy, to 39·3827 in English; of Captain Kater (English), 39·37079; of Mr. Hassler (U. S. Coast Survey), 39·3802. Doubts have been thrown upon the correctness of all these measurements.

"The length of the pendulum vibrating 100,000 seconds per day at Paris was found to be ·74193 *metres* (29·2192 in.), from which was afterwards deduced by calculation, the length of the pendulum vibrating the usual seconds of 86,400 a day, equal to ·99383 *metres* (39·1393 in.) or 440.$\frac{88}{100}$ *lignes* of the old French foot.

"The weight of distilled water contained in a cubic *decimetre* was found to be 18·827$\frac{15}{100}$ grains French, equal to 15·445$\frac{44}{100}$ grains troy, which is the weight of the *kilogramme*.

"The capacity of the vessel containing this water is the capacity of the *litre*, which is equal to 61·02624 cubic inches. This is the standard unit for wet and dry measure.

"The principle of decimal arithmetic was applied to all these units. The multiples were tenfold, and the subdivisions were tenths, so that in any sum representing French measures, each figure has ten times the value of its right hand neighbour. To all the multiples of the system, Greek words are prefixed, and to all the subdivisions, Latin words.

"The actual standard measures of the *metre* and the *kilogramme* were deposited with the keeper of the public archives, with great form and ceremony, upon the 22d of June, 1799.

"The temporary weights and measures provided by the law of August 1st, 1793, were abolished and the definitive substitutes were established by law upon the 10th of December, 1799.

"The establishment of the French decimal metrical system has thus far been described. The process of modification and repeal of compulsory measures followed. We have already seen that the law of April 7th, 1795, repealed the compulsory use of the second of $\frac{1}{100000}$ of a day. This was a revolt against 'decimal despotism.'

"On the 8th of April, 1802, a law was made, retaining the republican calendar for civil purposes, but restoring the week of seven days and the old Sundays.

"By the law of November 23d, 1802, the wine trade was relieved from the compulsory use of the new system, which required that the casks should contain a decimal number of *litres*. It was now permitted that the casks might be made of the ancient sizes and the contents in *litres* branded upon them. In the newspapers at Bordeaux the prices current at this day are quoted by the *tonneau* of 4 *barriques*.

"On the 9th of September, 1805, the new calendar (after an existence of twelve years) was abolished, and the ancient calendar was restored, so that January 1st, 1806, reappeared.

"On the 12th of February, 1812, an imperial decree, executed by an ordinance of 28th of March, following, abolished the compulsory provisions of the decimal system so far as to permit the use, for the purposes of commerce, of the following weights and measures:

Lineal measure.

Toise=2 *metres*, divided in 6 feet. On one side divided into *decimetres*, and the first division into *millimetres*.

Pied=$\frac{1}{3}$ *metre*, divided in 12 inches, each inch in 12 lines. On one side divided into 3$\frac{1}{3}$ *decimetres*, and subdivided into *centimetres* and *millimetres*.

Aune=1·2 *metres* divided into $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{10}$, $\frac{1}{5}$, $\frac{1}{9}$, $\frac{1}{12}$. On one side marked in decimals of *metres*.

Capacity.

Boisseau=12$\frac{1}{2}$ *litres*, also its double, half and quarter.

Litre=also its subdivisions of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, for retail sales of wet and dry measure.

Weight.

Livre=$\frac{1}{2}$ *kilogramme* or 500 *grammes*=16 *ounces*, also subdivisions of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$ths.

Ounce=31·25 *grammes*=$\frac{1}{16}$ *livre*, also subdivisions of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$.

Gros=3·90625 *grammes*=$\frac{1}{8}$ ounce.

Thus after twenty years of contest and confusion, the old names and the old subdivisions were restored, but with new and uniform values.

"This led to many years of confusion and fraud, followed by another change, decreed by the law of July 4th, 1837. This law was executed by the royal decrees of April 17th and July 10th, 1839, and put in operation in 1840, when the existing decimal metrical system was finally established, after a struggle of 47 years, a period of two generations, during which the entire active population of France was changed.

"The preceding history is given to show the extreme difficulty of effecting a change in the weights and measures used by the people, even when a reform was most needed, because of the greatest confusion and diversity of the weights and measures in use, and when the change was enforced by the most bloody and arbitrary despotism of modern times, favoured by the best of opportunities.

"Although the *metre* was drawn from the circle and the sphere, these two forms resisted the application of the decimal metrical system. The measurements of time, of the degrees of the circle, of navigation, geography and astronomy, successfully rejected it, although the prime idea of the Commission was to connect these subjects with ordinary weights and measures, by making the *metre* (the 40 millionth part of the circumference of the earth), *the unit of lineal measure*, and the *second* (the hundred thousandth part of the day) the *unit of time*, by means of the pendulum beating 100,000 seconds. The *metre* and the *second* were then the intermediate links in a long chain connecting science and practical life, having the solar system at one end, and a quart measure at the other. It is singular that the parts of this chain applicable to the calculations of science, were at once abandoned for their inconvenience; and the parts applicable to the uses of yard sticks, pound weights, and quart measures, were imposed upon the people by compulsory laws for nearly twenty years, without regard to the still greater inconvenience to them.

"Excuse for this partiality may be found in the facts, that the division of the day into 86,400 seconds, and of the quadrant into 90 degrees, was uniform throughout France, and throughout the world; that, although the day and the quadrant were not decimally divided, they were conveniently divided according to the nature of things; that there was a great value invested in the clocks and watches, and instruments for measuring time and circles, and in the tables and calculations already made for the purposes of navigation, mensuration and astronomy, which would become useless if the changes were persisted in.

"In fact, there were all the reasons for not making these changes, which we have now against the changes proposed to us: and there was no stronger motive. These reasons prevailed, and these changes were abandoned.

"From these remarks we may infer why the French people resisted a reform conferring such benefits upon the nation, and perfecting its unity. Of course, the first objection was that it was a change; a change which required them to unlearn much of their little learning, to abandon many of their old customs, and to embrace new things with outlandish names. The philosophers laughed at this reason, but they yielded to it themselves.

"If this objection had existed alone, the strong hand of the government—persisting for twenty years—must have conquered it. But there were other and more enduring reasons. The new system was not so perfect as to be in all cases preferable to the old. The usual divisions and subdivisions of weights and measures are the result of the natural selection of thousands of years, and they are in harmony with the daily wants and usages of practical life, requiring divisions of quantities into halves, thirds, quarters, sixths, and eigths, not always convenient in decimals.

"But whatever were the controlling reasons which incited the opposition to a change in France, they have much greater force with us from the absence of motive. We have no such confusion and diversity as the French had, and no such reform is called for. Our money is already decimally divided, and we enjoy already the chief benefits which the new system gave to the French.

"If the measurements of the weights and the dimensions of substances, when ascertained, were only to serve as data for complicated calculations, the reasons for adopting weights and measures decimally divided, would have controlled the practice long ago. This is actually the case with us; in surveying land, which is measured by chains twenty-two yards long, divided into one hundred links; in civil engineering, when embankments, excavations, &c., are measured by yards and tenths, or feet and tenths, as the case requires; in the measurements of ships for tonnage, when the three dimensions are taken by feet and tenths; and in gauging casks, which is done with a gauging rod marked in inches and tenths.

"But the fact is, that the vast majority of weighings and measurings are followed merely by mental calculations; or, by a simple multiplication of quantity (whole or fractional) by price (in decimals), a process which can oftener be done by vulgar fractions, more easily than by decimals.

"The *metre* is really as arbitrary a standard as the foot. About 80 degrees of latitude have been measured, but no two of them have been found of the same length, and there is good reason to believe that the length is not permanent in the same place. The only real thing about it is the rod in the public archives. The length of the *metre* is to be recovered, if lost, by comparison with the length of the seconds pendulum, and so likewise is the length of the foot or yard.

"The *metre* was adopted in France for the lineal unit, in preference to the length of the seconds pendulum, only because the harmonious proportion between the *metre* and the length of the meridian would bring all local measurements into harmony with the measurement of the world, and would be a great assistance in geography and navigation; but the decimal divisions of the quadrant and of time having been abandoned, and the adopted length of the *metre* having been found incorrect, there remains

not even a sentimental reason for our adopting it as our unit of measure. Our own convenience should be our guide, and overwhelming reasons forbid us to incur the confusion, labour, and expense of attempting to make a change of that kind.

"In the opinion of your committee, the *metre* in any shape heretofore adopted, is a less convenient instrument for measurement than a two foot rule. You cannot fold it into four without breaking the sub-units. If so folded, it would be ten inches long, which is inconvenient for the pocket. The *metre* is only decimally divided, whereas the foot rule, besides being divided into tenths and hundredths, is also divided into twelve inches, and gives the even $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{10}$, $\frac{1}{12}$, and $\frac{1}{100}$ of the foot, and the $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{10}$, $\frac{1}{12}$, and $\frac{1}{100}$ of the inch.

"By changing our unit of lineal measure for the sake of uniformity with France, we should sever our uniformity with Great Britain, a country with which three-fifths of our foreign commerce is transacted.

"The change in our units would entail much greater expense than is usually imagined. The measurements of every plot of ground in the United States have been made in acres, feet and inches, and are publicly recorded with the titles to the land, according to the record system peculiar to this country. Hundreds of years would elapse before we could permit ourselves to forget these old measures. Besides this, the industrial arts during the last fifty years have acquired a far greater extent and precision than were ever known before. Take, for instance, the machine shops, in which costly drawings, patterns, taps, dies, rimers, mandrils, gauges, and measuring tools of various descriptions for producing exact work and repetitions of the same with interchangeable parts, are in common use.

"It has been calculated that in a well regulated machine shop, thoroughly prepared for doing miscellaneous work, employing 250 workmen, the cost of a new outfit adapted to new measures would not be less than 150,000 dollars, or 600 dollars per man. If, instead of changing the sizes, we adopt the alternative of giving the French dimensions to the old sizes, the irreconcilable discord between the inch and the divisions of the *metre*, would furnish a precious example of the simplicity of the decimal system.

"If new weights and measures are to be adopted, all the scale beams in the country must be regraduated and readjusted; the thousands of tons of brass weights, the myriads of gallon, quart, and pint measures, and of bushels, half-bushels, and peck measures, and every measuring rule and rod of every description throughout the land, must be thrown aside, and others, which the common mind cannot estimate, must be substituted.

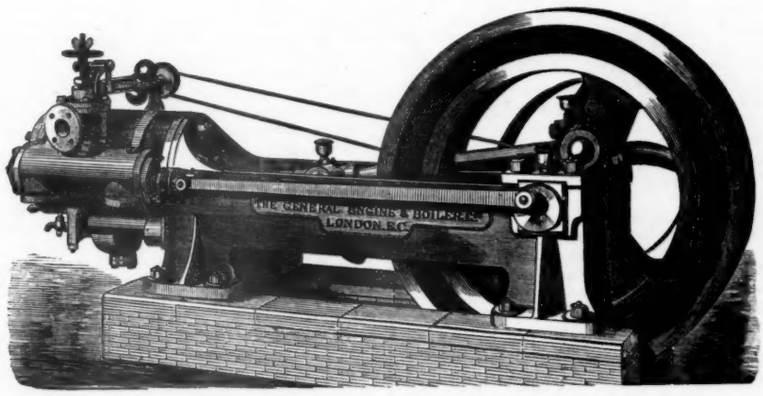
"The great mass of English technical literature would become almost useless, and must be translated from a language which we, and the nation we have most to do with, understand perfectly, into a new tongue, which is strange to most of our people. As a question of cost, let those who advocate this change consider it carefully.

"To the teacher, to the closet scholar, to the professional man, to those who never handled a rule or a measure, but only use weights and measures in calculation, it may seem mereby a matter of legal enactment; but to the worker, the dealers in the market places, to those who produce the wealth and prosperity of the land, the question is a most serious one.

"The Franklin Institute has never placed itself on record as opposing true progress; it has always advocated changes which were beneficial and not destructive. In this case, a majority of your committee believe that the ultimate benefits of the change proposed would be of less value than the damages during the transition. They think that the government of the United States has already done all that can fairly be asked of it by the most enthusiastic advocate of the metrical system, by making it legal. Those of us who choose to do so, can use that system, and no one can object to it; but, for the government to require us to use that, and no other, would be an arbitrary measure which we are neither willing nor able to bear.

"The majority of your committee are of opinion, and so report, that the objections to the attempt to adopt the *metre* as a standard unit of lineal measure are overwhelming, whether we consider the compulsory means proposed, or the end to be attained.

"All of the objections to the metrical decimal system do not apply to the adaptation of the decimal scale to our existing units. In the decimal harmony between the cubic foot and its content of water weighing 1000 ounces avoirdupois, whereby a cube of $\frac{1}{10}$ of a foot on the edge becomes the measure of the ounce of water, we have the means of constructing a decimal system of weights and measures which would interfere the least with existing institutions. But your committee do not feel called upon to consider this branch of the subject."



PATENT HORIZONTAL "EXPRESS" ENGINES.

At the recent show in the Agricultural Hall was exhibited by the General Engine and Boiler Company a small horizontal engine, of which we give an engraving, and which to our mind is the model of what an engine of moderate power should be. The framing is extremely rigid and well designed, being arranged to withstand the thrust and pull of the piston in the direct line of strain, and the engine is thoroughly well made, its exhibitors claiming that it works with half the usual consumption of fuel. The construction is very simple, reducing, as far as possible, its liability to get out of order. The engine is perfectly balanced by the employment of two counterweighted fly-wheels, and is self-contained, requiring no independent pedestal, and but very slight foundation. The valve is an equilibrium slide valve. The working parts are few in number and simple in form. The bearing surfaces are of ample area, carefully fitted, and provided with efficient means of lubrication. The workmanship and materials are of the best description; all the principal parts are got up bright, and the cylinder is neatly cased, to prevent loss of heat by radiation.

The indicated horse power of an engine of 20 nominal horse power, with steam at 50 lbs. pressure, and cut off at about half stroke, is 45 horse power; the diameter of the cylinder of this engine would be 12 inches, length of stroke, 20 inches, number of revolutions, 120 per minute.

STENOCHROMY.

A PAPER was read by Mr. E. Meyerstein at the Society of Arts, on Wednesday, December 13, on a new process for printing a number of colours at one and the same time, the invention of a German, Mr. Otto Radde, of Hamburgh. The following is the substance of the paper :—

Colour printing was originally invented by Senefelder, towards the close of the last century, and since then innumerable attempts have been made to print more than one colour by one impression; the more noteworthy attempts in that direction were made by Laurent, Muller, Macready, and latterly by Messrs. Johnson, whose mode consisted of piecing together a number of small colour-blocks similarly to a child's puzzle ; but has now been abandoned, being found impracticable.

Those who are conversant with colour-printing know how many fruitless attempts have been made to attain the object in view, and how hitherto every experiment has ended in failure and disappointment. They will also be able to appreciate the immense mechanical difficulties that had to be overcome, and will scarcely be astonished to hear that the present invention is the result of many years' study and uninterrupted costly experiments.

The chief difficulty to overcome was to produce colours of equal consistency or yielding power, and though the recipe was simple enough when it was known, it was only discovered after years of persevering researches, which necessitated the building of a colour mill and of a large printing establishment, for it occurred several times that, when the inventor thought that he had solved the problem—experimenting at that time with small quantities—he found himself as far as ever from the goal when he followed up his theory on a large scale.

The composition of the colours employed for stenochromatic printing consists of various fatty and oleaginous substances, mixed with ordinary colours—but colours of the very best quality—in such a manner that a kind of soapy pigment is obtained. It is, however, indispensable that these pigments should possess the following qualities :—

1st. They must melt when exposed to a certain degree of heat, and when cooled, after being rendered fluid by heat, they should solidify to about the consistency of butter on a cool day.

2nd. Whatever the colour of the pigments, they must all be of identically the same specific gravity and yielding power. This requirement was one of the greatest stumbling-blocks in perfecting the invention, and to overcome this difficulty, the ingenuity and the patience of the inventor were taxed to their utmost limit during several years' persevering experimentalising, the colours ordinarily in use varying very much in specific gravity and yielding power.

3rd. They must, under all circumstances, retain their original brilliancy and softness of colour, so that neither sun-light, heat, nor the action of the atmosphere, can effect any change whatever.

The composition, or the colour, is always used in a fluid state produced by heat, the required quantity of solid colour being placed for that purpose in a tinned copper pan with a handle, and a spout or nose for pouring out the colour.

The operator takes a frame of about two inches in depth, and adapted in its dimensions to the size of the object to be produced, and proceeds thus :—Supposing the groundwork of the picture about to be copied to be black, a certain portion of the interior of the frame is filled with a black colour, which is prevented from running all over the surface by inserting within the frame some thin protecting plates or slips. The colour solidifies quickly; the outlines of the picture, or a portion thereof bordering on the groundwork, is traced on the colour, the slip is removed, and the colour is cut away to outlines, by means of a sharp knife, which acts in a vertical direction. Another slip is then applied, another colour poured in and allowed to cool, the required outline is again traced thereon, the slip removed, and the knife cuts again according to the tracing.

These operations are repeated until the entire picture is reproduced. The frame is of wood, and to enable the operator to vary the depth of the colour-substance according to the number of impressions required to be taken, it should be a double one, so as to slide it up and down telescopically.

The cutting knife is held in a jointed frame like a lazytongs, or similar appliance, which, whilst ensuring an exact vertical direction, allows the knife to travel in any desired latitudinal direction. To ensure a true vertical direction, which is of paramount importance, a spirit level may be attached to the holder of the knife.

The table upon which the work is done should be of marble, and adjusted by means of a spirit-level. On its surface, or otherwise attached to it is a strong arm, supporting the lazy-tongs and the knife held by them. Since it is necessary for the purpose of correctly tracing the outlines of the picture upon the colours, that these should be level, a levelling knife, preferably of triangular cross-section, is passed over the frame, and the colouring matter is thus reduced to a fairly even surface.

To obtain correct outlines of the original to be copied, a tracing medium is used ; when the outlines are traced thereon they are perforated, and by means of chalk, charcoal, or other suitable material, transferred to the colour-block.

When the picture, or rather the colour-block, has been so far finished, it is taken to the press, where, by means of a horizontal knife, it is first levelled ; then the material upon which the impressions are to be made is placed over the colour-block ; a zinc plate is lowered, rollers working in a groove on either side are, with slight pressure, passed over it, and a stenochrome is then produced. By means of mechanical contrivances, the colour-block, after an impression has been taken, is raised sufficiently to yield the same amount of colour for every consecutive impression. The mechanical contrivance for raising the colour-block regularly by almost infinitesimal degrees was not easily constructed. The engineers had to alter the mechanism again and again, and more than one engineer gave up in despair the attempt to carry out the ideas of the indefatigable patentee.

In order to finish the picture it is only necessary to make one, two, or at most, and in very exceptional circumstances, three other printings ; these are made by lithography in the ordinary way, and consist of the key-stone to supply the details, as in ordinary chromo printing, and sometimes one or two blending plates.

The paper for stenochromatic purposes should be made from clean cotton rags ; it should be very absorbent and even in texture, and free from all starch and chemicals ; previous to being used, it is damped with a special resinous solution, and afterwards passed over a heated surface, so as to allow any excess of moisture to evaporate.

The author of the paper then proceeded to exhibit three sheets, each of which contained seventy-two distinct shades of colour, printed with one impression ; these had been kept for months exposed to the action of the heat of a fire, for the purpose of ascertaining whether the colours would fly, which they certainly do not. On these sheets each column of colours ended in a white square—printing in white being a novelty.

The next sheets exhibited were prepared with the intention of fixing a colour gauge, which might serve as a standard for the whole world ; and it is interesting to learn what led to the conception of the idea, and how the inventor intended to carry it out. In every trade or profession in which colours are used, it occurs frequently that persons wish to order some coloured material from a merchant or manufacturer living in a different town or country ; not having a specimen or sample of the particular shade required—let us say, a green—they obtain the nearest shade to that which they desire, and then write to the merchant, perhaps, as follows :—Please let the colour be of a rather bluer, or yellower, or deeper, or lighter, tinge than the sample. The manufacturer accordingly uses his own discretion, and supplies what he thinks will please his correspondent. But, in most such cases, he will find that he has made the shade too yellow, or too blue, or too deep, or too light, or *vice versâ*. Hence, disappointment and troublesome litigation only too often arise.

To remedy these evils, the inventor has devised the plan of the colour-gauge ; but to render such gauge of any value, and of artistic as well as commercial utility, it was found necessary to elaborate the details of its composition with very great care. He divides or graduates each of the seven colours of the spectrum into about ten colours ; and each of these he shades off towards the top in eleven equal gradations into black, and towards the bottom in the same number of equal gradations into white. Thus seventy-three colours each, in twenty-one gradations, are obtained.

It is proposed to treat all the colours of the spectrum in this manner. The whole will then form a set of eighty colours each, in twenty-one gradations from black to white. Every card will bear a distinctive number at the top, and will be lettered from A to V down the side. Supposing a London merchant wants to order some coloured cloth from a firm in Glasgow, it will suffice if he writes colour number so and so, shade letter so and so, provided, of course, that both have got this colour-gauge. The colour-gauge is accompanied by a small instrument, which allows of one shade of colour only being seen at a time, so that the correct shade may be easily found. This system of a

DESIGNS FOR ART WORKMANSHIP.—CHAIR IN CARVED OAK, UPHOLSTERED IN LEATHER OR VELVET.

standard colour-gauge would have little to recommend it were it not for the two important facts that—firstly, the stenochromatic colours never fade or change, and that, secondly, any and every shade of the proposed gauge can be reproduced with mathematical exactness after any length of time.

Many examples of the process were exhibited, and the results were very remarkable—in most instances rivalling the productions of chromo-lithography. The brightness and purity of the colours were most striking, and this is due to the fact that each colour, as it were, maintains its own ground, and is not, as in the ordinary process, dimmed by repeated over-printings. This in itself stamps stenochromy as a process quite distinct from any of those now in use. It is not an improvement merely on chromo-lithography or on oleography; it is an entirely new mode of producing coloured designs and pictures. This purity and freshness of colour is more particularly observable in the flesh-tints produced by the stenochromatic process. In these, above all, the productions of oleography and chromo-lithography are weak, in consequence of the many manipulations they have to undergo. It is a general complaint, more particularly against oleographs and similar productions, not only that after a comparatively short time they fade, but, what is worse, that colours like yellow, brown, and chrome become more glaring, while flesh-tints and other delicate colours become paler. Hence it is frequently seen, that what was at first a very creditable production becomes after a while a perfect caricature. On the other hand no change of colour will ever take place in any stenochrome. As long as there is a shred of one left, the original tints will retain their original brightness and softness.

The new process offers, besides the excellence of its results, considerable advantages in respect to the time necessary to produce impressions of a picture, as also in the reduction of the cost of production.

A specimen of the process was circulated with the journal of the society, which may be taken as a specimen of quick colour printing. The sheet contained a design of a bunch of flowers, in which were between thirty-five and forty distinct shades of colour; six thousand sheets were printed in twelve days—including the time for preparing the design—and it is stated that, had they been required, sixty thousand copies could have been produced within the same time. The example consisted of a single printing—to make a finished picture one over-print would have been required to give the outline distinctness.

CHAMBERS, BROTHER, & CO.'S ARCHIMEDEAN BRICK MACHINE, PHILADELPHIA.*

THIS machine belongs to the class known as "tempered-clay machines," or "clay-tempering, brick-making machines," and was invented by the junior member of the firm, Cyrus Chambers, Junr., who is already well known to the public as a mechanic and inventor.

The machine is constructed almost wholly of iron, and is made very strong and durable.

It tempers its own clay with water, taking the clay as it comes from the bank, without any previous handling or preparation, and forms it into bricks, with well-defined corners, and smooth, straight surfaces, at the rate of from fifty to eighty per minute, or from twenty-five to thirty-five thousand per day of ten hours.

The clay is taken direct from the bank and dumped at the side of a conical funnel that leads into the tempering case of the machine, and mixed, when necessary, with loam, sand, or coal, and the requisite amount of water being added to temper the clay to the proper consistency; the mass is shovelled into the hopper and falls into the machine.

The tempering portion of the machine consists of a strong iron case, in which revolves a horizontal shaft, into which are set spirally, strong tempering knives, or blades of steel, so that, as they pass through the clay, they move it forward. The clay being stiff, and not having much water on it, is not liable to slip before the knives, but is cut through and through, and thoroughly mixed; so that by the time it reaches the small end of the tempering case it is ready to be formed into bricks.

On the end of the tempering shaft is secured a conical screw, which revolves in a cast-iron conical case, the inside of which is ribbed, lengthwise, so as to prevent the clay from revolving in it, and is chilled, to prevent wearing.

The screw being smooth and very hard, the clay slides on the screw, thus becoming, as it were, a nut; the screw revolving, and not being allowed to move backward, the clay must go forward.

This operation further tempers the clay, and delivers it, in a solid, round column, to the forming die, which is of peculiar construction and form, and so designed as to reduce the round column to a rectangular one, whose breadth and thickness is the proper breadth and thickness for a brick, while at the same time it forces the clay into the corners of the square or rectangular, finishing part of the die, so that the angles of the bar of clay are made very solid and sharp, thus insuring perfectly square and well-defined corners to the bricks.

This bar, as it issues from the die, is conducted by a plate to the cutting device, which consists of a thin blade of steel, secured to the periphery of a wheel, in the form of a spiral, the distance between the blades of which is that required for the length of a brick.

This spiral knife runs perpendicularly, in an endless chain, which supports the bar of clay at one edge and bottom, so that the blade in passing through, the clay being supported, thus insuring the angles unbroken, and the cutting smooth and square.

The distance between the spiral blades being uniform, the lengths of the brick are absolutely uniform, thus overcoming the great practical objection hitherto existing in the Chambers' machine.

The drawing cut of the spiral, cuts the end of the bricks perfectly smooth, thus correcting another defect hitherto existing in this class of machines.

The speed of this spiral cutting blade is controlled by the clay itself; hence no matter how irregular the flow of clay, the spiral runs in exact unison therewith; consequently, the absolute uniformity in the length of the bricks.

This controlling of the speed of the spiral by the clay is so positive with that of the clay that it will run at any speed, from one to one hundred bricks per minute, while the machine runs at full speed.

These cutting and regulating features are the new parts, and overcome the only valid objection heretofore urged against this machine as now introduced.

The bricks, thus cut from the continuous bar, are separated and carried by another endless belt through the dusting or sanding machine, which consists of a chamber, into which is thrown, by centrifugal force or a blast of air or steam, a continuous cloud of dust or fine sand, which adheres to the surface of the bricks, rendering them much nicer to handle, preventing them from sticking together on the barrows, or in the hacks on the drying cars, and much improving them in colour when burnt.

Provision for Stones.—All brick clays have more or less stones in them, and as it is impracticable to pick them all out, there is a necessity of making some provision for them, even if there should be only one stone in every "ten thousand of clay."

The tempering knives run six inches from the tempering case: hence there is no danger of a stone five inches in diameter catching between the end of the knife and the case, but they frequently imbed themselves in the clay that occupies the space between the ends of the knives and the case. If the stone is more than three inches in diameter, it will lodge at the entrance of the screw, preventing the clay from passing to it, and causing it to issue at the safety valve, through which the stone may readily be removed. If a stone, less than three inches in diameter, it will go through the screw, the openings between the threads being less at the entrance than at any other point, so that a stone that once fairly enters the screw, cannot lodge until it has reached the forming die, where it will lodge, if it is larger than a brick is thick, and prevent the proper flow of clay, causing the bar to split in two, or only part of a bar to issue. This forming die is secured to the screw-case by a hinge and hook-bolts, so that in less than one minute the die can be swung open and the stone knocked out, when the die is closed and the machine again started.

Small stones occur much more frequently, and pass freely through the machine, being buried in the bar of clay and passing to the "cut-off." When the stone should happen to be buried in the bar of clay at the line of severance, the knife must either cut through the stone, be broken, or some provision made by which it shall not be injured. The first is not practicable, as the stones are often very hard, and to break a knife every time it should happen to strike a stone would render the machine useless.

In order that the knife should not be affected by stones, the wheel to which it is secured is held in position by a spring which holds it with just sufficient force to compel the knife to pass through the bar of clay. When the knife comes in contact with any hard foreign substance, as stones, brickbats, or bones, the

* Paper read before the meeting of the Franklin Institute.

spring yields, and allows the knife to move back, and thus cuts to it, the knife immediately returning to its original position, ready to cut through the bar again—as the inventor demonstrated, by accidentally allowing his hand to remain in the cutting device when the knife came round, cutting two fingers "to the bone," when it yielded, leaving the bone uninjured, and the machine ready to cut the next brick.

This machine moulds the bricks stiff enough to be "hacked" at once in the drying sheds.

With these recent improvements, the inventor claims this machine to be the most practicable, durable, and economical brick-making machine yet introduced.

WOOL DYEING.*

By George Jarmain.

Lecture III.

COLOUR has been well described as the impression which the light, reflected from the surface of a body, makes upon the eye.

Sunlight contains seven colours, which are called the prismatic colours, because they are obtained by the aid of a prism. The surfaces of bodies have the power of reflecting these colours. When all are reflected, the body appears white; when none are reflected, the body appears black; when part are reflected and part absorbed, the reflected ones give their own impression to the eye; and thus there is produced that infinite variety in combination of colour with which we are so well acquainted.

As gaslight and most artificial lights do not contain the whole amount of the prismatic colours which are found in sunlight, those which are not present are not reflected from the surface of bodies, which often appear differently coloured by gaslight to what they do by daylight. When a body is seen under the influence of a monochromatic light, such as that of sodium, we see these effects greatly exaggerated. As there is only one of the prismatic rays in the sodium flame, namely, the yellow, only the yellow portion of the colour of bodies is seen under its influence, the other part appearing black, or very dark.

As the colour of a body depends upon the power which its surface possesses of reflecting certain prismatic rays, it is evident that the art of dyeing consists in fixing upon the fabric a substance which will enable its surface to reflect rays different from those reflected by the fibre in its natural condition.

Substances which have the power of changing the reflecting condition of the surface of a body are called colouring matters. Many of these tinctorial agents are derived from the vegetable kingdom, as the dyewoods, some from the animal, as cochineal, whilst others, and a numerous and interesting class, are artificial productions. Each colouring matter has special characteristics of its own, which require a special study, in order that they may be utilised by the dyer to the best advantage. These individual properties and peculiarities will occupy our attention during the succeeding lectures.

For dyeing purposes, only those colours can be utilised which are soluble in spirit or water, and which have an attraction or affinity for fibre, the colour imparted to the fibre having body, beauty, or permanency, and not being a mere irregular stain. Colours which are insoluble are pigments that can be utilised by the painter and printer, but are of no service to the dyer.

Mr. Bancroft divided colours into two classes;—those which possess the power of attaching themselves to the fibre without the aid of a third body he called substantive colours, and those which require the intervention of a third body to enable them to fasten themselves upon the fibre he called adjective colours. This distinction, though not very sharp, is very convenient, and has been generally adopted.

The distinction is not sharp, because colours are frequently adjective to one fibre and substantive to another; and often a substantive colour may be very greatly improved by the aid of a third body, when it then virtually becomes an adjective colour.

The colours, which are substantive to woollen tissue, are:—the aniline colours, picric acid, indigo, cudbear, and archil; the red and yellow woods partially.

The colours which are adjective to wool are—logwood, the red and yellow woods, flavine, turmeric, madder, cochineal, and lac dye, &c.

*A course of Cantor Lectures, reprinted by permission from the Journal of the Society of Arts.

Fast and Loose Colours.

The dyer must take account of the degree of permanence which his colours will be expected to possess. If the goods, after leaving his hands, have to be scoured in soap and alkaline liquids, and to be milled under the stocks, and then, when worn, to be exposed for a prolonged period to sunlight and atmospheric influences, to sea spray, and perspiration, &c., the dyer will fix upon them his fastest colours; but if they be articles of dress which have not even to be washed after leaving his hands, and have to be worn only a few times, and then probably by artificial light, he may venture to put on a loose or fugitive colour. These colours are often bright and dazzling in direct proportion to their fugitiveness.

Few colours will withstand unimpaired the direct action of sunlight, the aniline and weed colours, and delicate shades, such as lavender and peach, pinks and greens, are often injured and spoiled when exposed to bright sunlight for a few hours.

The action of light upon colour seems to be that of a reducing or deoxidising agent.

Heat, moisture, and perspiration also affect colours injuriously.

The influence of dew upon colour has long been known; and before the use of chlorine as a bleaching agent, it was customary to bleach linen and calico by exposing the goods for a considerable time on grass, so that they might be submitted to the action of dew by night and sunlight by day.

The permanency of the colour is very much affected by the mode in which the goods are dyed; the duration of the time of boiling, the temperature of the dye-bath, the mordant used have each their influence on the stability of the dye.

The ordinary colouring matters which may be made fast upon woollen fabric by employing suitable means are the following:—indigo, logwood, the red woods, madder, the yellow woods, quercitron bark and flavine, cochineal, and lac dye.

The colouring matters which are more or less fugitive when applied to wool are—the aniline colours, cudbear, and archil, picric acid, turmeric, and Persian berries.

As a rule, colours are faster upon wool than upon cotton or silk; indigo is, however, faster upon cotton than upon wool.

Mineral colours do not answer well for wool, Prussian blue being almost the only mineral colour employed.

The difference in the tinctorial power of colour is very great: thus, one part of flavine will dye a given weight of wool which would require sixteen parts of bark to give the same shade of colour; and the depth of colour of the solution gives no indication as to its tinctorial power, for a pale yellow solution of picric acid will dye very much more material than an infusion of fustic which may appear quite dark with colour.

Fixation of Colour.

Opinions vary as to the mode in which colour becomes fixed upon fibre. Some contend that a true chemical combination takes place between the fibre and the colouring matter; others state that it is no true chemical combination, but that the colouring matter is attached to the fibre by a special force in which equivalent proportions do not obtain; others, again, say that the adhesive action is altogether mechanical, and that the colouring matters are absorbed into the pores of the fibre and held there mechanically. Some hold that the colour is fixed to the surface only of the fibre by molecular attraction; others think that the fibre is perfectly permeated by the colour. There are special reactions which lend force to each of these antagonistic opinions; but for all practical purposes they are not likely to influence the operations of the dye-house, and they are at the present moment more interesting as theoretical considerations than useful and capable of being turned to practical account in the dyehouse.

Mordants.

A mordant is a salt or other substance, by means of which colouring-matter can be fixed upon fibre which of itself has no affinity for it. A dyed fabric may, therefore, be considered to be a ternary compound of colour, tissue, and mordant.

There are but few colours which have the power of fixing themselves upon fibre permanently without the aid of a mordant; for, as a rule, without such aid, they produce a colour or stain which may, for the most part, be washed out by means of soap and matter. And even those substantive colours which can be used without the aid of a mordant, with one notable exception, namely indigo, are rendered both brighter and faster by the use of a mordant.

In the case of indigo, the oxygen of the air, which serves to render the indigo insoluble and thus to fix it upon the fibre, may be considered as its mordant, were it not that the term has been restricted to bodies which are capable of being applied in solution.

Mordants may be classified in two groups :—

1. Metallic salts.
2. Oils—Albumen and casein.

Metallic salts are the only mordants which are employed in the dyeing of woollen fabrics, and these are mostly confined to salts or other compounds of tin, aluminium, chromium, copper, and iron.

These compounds fulfil certain essential conditions of a good mordant, which are the following :—The mordant must be soluble, so that it can thoroughly permeate the fibre. If the mordant be already in solution, it must not cause the water to become turbid when it is added to the bath. The mordant must leave an insoluble deposit within the pores or upon the tissue submitted to its action. The insoluble deposit must be capable of forming a combination with colouring-matter, which, if it affect it in colour at all, it must brighten. The combination should take place slowly and with regularity.

The salts in common use as mordants for wool, which are found to fulfil the above conditions, are :—alum, and alum cake, bichromate of potash, copperas or protosulphate of iron, blue vitriol or sulphate of copper, and tin solutions.

Most of these salts are of an unstable character, the acid and base being held together by weak affinities ; this is notably the case with the iron and tin compounds. Alum and sulphate of alumina are more stable, but are decomposed by woollen tissue at a boiling temperature. Bichromate of potash is decomposed in a special manner, which I shall describe further on.

The insoluble matter deposited by the mordant on the fibre is either a subsalt of the metallic base, or a hydrate, or both combined.

The nature of the combination which subsists between the deposited matter and the fibre is involved in the same doubt and uncertainty as those which are encountered in studying the fixation of colour. The general opinion seems to be that the insoluble particles of the mordant are retained mechanically within the pores, or in contact with the cell walls of the fibre, or that they adhere to the external walls of the cells by some attractive force. Whatever may be the mode, however, by virtue of which they are attached to the fibre, they still retain all their properties of combining with colouring matter, and forming insoluble compounds with them.

Lakes.

As the insoluble matter precipitated upon the fibre is frequently a basic salt, the acid of the mordant often exerts a considerable influence upon the colours obtained. A chloride of tin gives a different shade of colour with logwood to that produced by a sulphate or sulpho-muriate of tin.

The fact that the colours obtained upon tissues are frequently different in shade, purity, and intensity, to the lakes produced with the same mordant and colour, seems to give force to the theory that the affinity which holds together the mordant and tissue is of a chemical character.

These insoluble bodies are combinations of the base of mordants with colouring matters; they are obtained when a solution of the mordant is added to a decoction of a colouring matter. Frequently the lake does not precipitate until a solution of an alkali is added to withdraw the acid from the mordant salt. It would thus seem that the action of the fibre upon the mordant is somewhat analagous to that of an alkali upon it, in causing a deposit of the mordant hydrate.

Modes of applying Mordants on Wool.

In wool-dyeing the goods are always mordanted at a boiling temperature.

Boiling seems to have the effect of opening the pores of the wool and expelling the air, thus giving passage to the mordant solution.

The mordant may be either applied before the dyeing operation, along with the colouring matter, or after the dye has been applied. Sometimes it is found advantageous to apply the mordant both before and along with the dye.

The application of too much mordant is to be avoided ; this is notably the case with the iron and bichrome mordants, which produce rusty and green shades respectively, when an excess of the mordant has been used.

Utensils employed in Mordanting.

The most convenient vessels for mordanting woollen goods are wood cisterns, 6 to 8 ft. long, 4 to 5 ft. broad, and 3 to 4 ft. deep, with a false bottom, made of perforated iron plates. The water is heated by a perforated steam-pipe, 2 in. in diameter, which passes under the plates along the middle of the cistern. When scarlets, oranges, and crimsons have to be dyed with an acid tin mordant, block tin plates should be substituted for the iron plates, which would seriously affect the colours, as iron salts would be formed by the acid acting upon the iron plates. Metallic iron also decomposes tin salts, the tin being precipitated in the metallic state.

$$\underset{\text{Stannous chloride.}}{SnCl_2} + \underset{\text{Iron.}}{Fe} = \underset{\text{Ferrous chloride.}}{FeCl_2} + \underset{\text{Tin.}}{Sn}$$

Large iron pans are also frequently used in both mordanting and dyeing, the water being heated, either by a steam-pipe blowing straight down into the water, or by direct fire-heat under the pan. The steam in this case is only employed to heat up the water to the boil, the subsequent mordanting or dyeing being done by the fire-heat alone. Many experienced dyers prefer direct fire-heat, especially for the dyeing, as a temperature can be obtained which is two or three degrees higher than what can be obtained by steam alone; and fire-heat is more especially preferred for wool, which is kept in a more constant state of agitation by the ebullition of the water than can be obtained by steam-heat. The wool is also less liable to be felted or twisted into tails.

A more uniform ebullition and agitation of the liquor may, however, be obtained by passing the steam-pipe, not perforated, several times along the bottom of the cistern, and allowing the condensed steam to discharge itself into the cistern by an upright pipe, bent over above the surface of the liquid. When the steam pressure is not less than 50 lbs. per square inch, this is an excellent and economical mode of heating both the mordant and dye baths.

When pieces are mordanted or dyed, they are kept in motion by causing them to pass over a wince, placed over the dye-vessel and turned by machinery. Three or four pieces are sewed end to end, and are thus passed over the wince continuously.

Wool is kept in motion by being stirred up almost continuously during the process by long poles, called "stangs." The thorough stirring and breaking up at the commencement is of great importance, in order to prevent unequal reception of both mordant and dye.

The mordanting usually occupies from one to two hours, the liquor is then run off from wool, and water run in once or twice to wash out excess of mordant ; it is then put in a coach or waggon, covered over with a sheet, and left over night, or longer if convenient. The colour obtained after leaving it in this manner is always better than when it is passed direct into the bye-bath after mordanting.

Pieces after mordanting are drawn out of the bath, washed on the washing machine, and left over night before dyeing.

Alum.

This was the first substance used as a mordant. It is a double sulphate of alumina and ammonia or potash. It was formerly manufactured from certain pyritic shales found on the east coast of Yorkshire, but now it is chiefly obtained by acting on burnt aluminous shales or clay, with sulphuric acid, and afterwards saturating the excess of acid by the addition of ammonia or potash, according as ammonia or potash alum is required. The active mordant agent in alum is alumina, of which potash alum contains ten per cent., and ammonia alum a little more. The latter is now more frequently met with in the market than the former. Ammonia alum may be recognised by stirring up a little of the powdered alum with quick lime or caustic soda, and moistening with water. The smell of ammonia will be given off from ammonia alum. The most objectionable impurity which alum contains is a ferrous salt, which may be detected by the well-known tests for iron, namely, prussiates of potash, or a solution of tannin.

Alum deposits upon wool fibre, with which it is boiled, aluminic hydrate $Al_2(HO)_6$ or subsulphate of alumina, according to the relative proportions of the alum and wool. When the hydrate only is left on the fibre, the sulphuric acid appears to have combined with ammonia formed from some gelatinous principle of the wool which is dissolved during the boiling. M. Havrez, late proprietor of the technical schools at Verviers, made before his death a long investigation into the different reactions which alum gives during the process of mordanting. The general conclusions at which he arrived were, that a weak bath of alum—that is, a bath containing less alum than $\frac{1}{12}$th of the wool—becomes alkaline, and affects colour in an alkaline manner. A larger quantity of alum than $\frac{1}{12}$th of the wool acts as a weak acid upon colours giving violets upon logwood and the red woods. Large quantities of alum upon cloth act upon colours as alum itself does, giving acid effects, whereas small quantities act as hydrates, giving alkaline effects.

The addition of an acid has the same effect as using an excess of salt, and it is found to be useful in extracting the iron from the fibre, which thus becomes purified.

Alum is sometimes employed alone as a mordant, but more frequently conjointly with other mordants. Alone it gives bright colours.

During the preparation of these lectures it occurred to me that it would be useful to know what is the action of each mordant, when fixed on wool, upon the colouring matters commonly employed in the dye-house. I am of opinion that these effects are much more instructive to the young dyer than the examination of the precipitates which the mordants give with the decoctions of the dyes. I have accordingly mordanted samples of wool with the following mordants—muriate of tin, alum, sulphate of copper, bichromate of potash, and copperas; and have dyed them with the following colouring matters—fustic, flavine, American bark, turmeric, sumach, madder, barwood, saunderswood, camwood, and cudbear; and have arranged them in this tabular form in order that the action of any of the above mordants on the dyes may be readily seen. Fifty per cent. of the weight of the wool in colour was used with the following dyes:—Fustic, bark, sumac, madder, camwood, barwood, saunderswood, and logwood; 4 per cent. with fustic, 12 per cent. with cudbear. The following quantities of mordants were employed:—2 per cent. bichrome for logwood, 1 per cent. for the other colours; 8 per cent. copperas, with 2 per cent. tartar added; 12 per cent. alum, with 2 per cent. tartar; 8 per cent. blue vitriol, 8 per cent. muriate of tin of 60° Tw. One hundred grains of well-scoured and raised white wool was found to be a convenient quantity to operate upon. The mordanting and dyeing were done in an enamelled iron pan, holding about a pint, and heated over a Leoni's gas stove. The wool was boiled with the mordant for an hour, wrung out, and left over night. The dyeing, which also occupied an hour, was done next day. [These patterns were frequently referred to during the lectures as illustrations of the effects of the mordants on the dyes, and the lecturer strongly recommended the young dyer to prepare a similar table for his own use, in order that he might familiarise himself with the use of the various mordants and dyes.]

Copperas.

This is another mordant which has been used a long time. It is the crystallised protosulphate of iron, called also ferrous sulphate. It is manufactured chiefly from soft pyrites, which are met with among coals and in the coal shales. The pyrites, when exposed to air and moisture, readily oxidise, and form sulphate of iron and free sulphuric acid. The liquor is boiled with scrap iron, and then crystallised.

The most serious impurity to which copperas is subject through mismanagement is alumina. To detect this, the copperas should be dissolved in water, and fully peroxidised with nitric acid, and then precipitated with excess of pure caustic soda and filtered. The alumina, if present, will be precipitated from the filtrate by the addition of a solution of chloride of ammonium.

The use of copperas has been greatly lessened by the use of bichromate of potash as a mordant for logwood colours, especially blacks on pieces. Some of the best wool-dyed blacks are, however, still done with copperas.

The same explanation of the deposition of the ferrous hydrate upon wool as was given for alum will be sufficient, with this difference—that the ferrous hydrate deposited very quickly becomes partially oxidised into the form of ferric hydrate by the oxidising action of the air. A dyer, however, tells me that he has detected iron in the ferrous condition in the wool, even months after it had been mordanted. This fact seems to prove that there is a true chemical combination between the mordant hydrate and the wool. The reducing action which wool undoubtedly possesses may also assist in restraining the oxidising action of the air.

Tartar or argol is almost invariably used along with the copperas, in order that the solution may be kept clear, and the too rapid dissociation of the copperas prevented. The tartar, in this and every case where it is used with a mordant for a similar purpose, should be added to the bath first, for it is easier to prevent a precipitation than to redissolve the precipitate after it has formed. Copperas is frequently used simply as a saddener. Its effect upon colours is to produce dark shades. It is used both alone and in conjunction with alum and sulphate of copper, but not with bichromate of potash, which it reduces, and renders its special properties less effective as a mordant.

Sulphate of Copper,

Called also blue stone, blue vitriol, and Roman vitriol, is not used extensively as a mordant, and never alone. It is used along with alum to obtain logwood blues, and with copperas to produce blue blacks.

Bichromate of Potash.

This splendid salt is met with in commerce in a state of almost absolute chemical purity. I think it is more extensively used in our woollen dyeing than any other mordant. Its decomposition in the bath in contact with wool is different from that of any other mordant, for its constitution is different. The metal which is deposited as a hydrate upon the wool, is present in this salt as the acid, and not at the base, which is potash. Bichromate of potash may be represented as being neutral yellow chromate of potash, in combination with dry chromic acid; thus:—

$$\underset{\text{Bichromate of potash.}}{K_2 Cr_2 O_7} = \underset{\text{Chromate of potash.}}{K_2 Cr O_4} \quad \underset{\text{Chromic acid.}}{Cr O_3}$$

To obtain the full effect of the bichromate as a mordant, sulphuric acid is usually employed along with it; the whole or major part of the chromic acid is thus set free:—

$$\underset{\text{Bichromate of Potash.}}{K_2 Cr_2 O_7} + \underset{\text{Sulphuric acid.}}{H_2 SO_4} + \underset{\text{Water.}}{H_2 O} = \underset{\text{Sulphate of potash.}}{K_2 SO_4} + \underset{\text{Chromic acid.}}{2\,H_2 Cr O_4}$$

Chromic acid is a most powerful oxidiser, and acts energetically upon wool, and should, therefore, be used with caution, as we shall see further on. The wool furnishes the reducing agent, probably in the form of hydrogen, which acts upon the chromic; thus:—

$$\underset{\text{Chromic acid.}}{2\,H_2 Cr O_4} + \underset{\text{Hydrogen.}}{3\,H_2} = \underset{\text{Water.}}{2\,H_2 O} + \underset{\text{Chromic hydrate.}}{Cr_2 (HO)_6}$$

The chromic hydrate thus produced is deposited upon the wool as the mordant hydrate, a portion of neutral chromate of potash is also usually present on the fibre.

I have ascertained experimentally that it is not safe to use more than three per cent. of the weight of wool of bichromate, for if four per cent. be used the colour becomes impaired, and if twelve per cent. be used the wool cannot be dyed with logwood at all, and the curious effects of over-chroming are produced. These effects are due to the destructive oxidising action of the chromic acid upon the wool. When a still larger quantity of bichrome is used along with sulphuric acid the wool is dissolved, and a solution of chrome alum is obtained, thus:—

$$\underset{\text{Bichromate of potash.}}{K_2 Cr_2 O_7} + \underset{\text{Sulphuric acid.}}{4\,H_2 SO_4} + \underset{\text{Hydrogen.}}{3\,H_2} + \underset{\text{Water.}}{18\,H_2 O} = \underset{\text{Chromium.}}{Cr_2 (SO_4)_3} \underset{\text{Potash.}}{K_2 SO_4} + \underset{\text{Alum.}}{24\,H_2 O}$$

The effects of using various proportions of bichrome upon wool, ranging from two to twenty per cent., were exhibited.

Tin Solutions.

These are generally called tin spirits. There are great numbers of them in use; every dyer and maker has his own special plan of preparing them, and generally firmly believes that his are the best in existence. I do not think it would be profitable or edifying were I to describe the mode of preparing all there are made; firstly, because I think that at least three-fourths of them are unnecessary, and secondly, because many of them are trade secrets.

The useful and only essential varieties are the following:—

The single and double muriates. These are prepared by dissolving granulated tin in commercial hydrochloric acid standing at from 33 to 36° Tw.; diluting with water down to 60° Tw. for the single muriate, and making the double muriate up to 80° or 100° Tw. or more.

The nitrate of tin is made by dissolving tin in single nitric acid of about 33° Tw., and free from nitrous acid. The tin should be added in small portions at a time, to prevent the precipitation of the tin as the insoluble binoxide, or metastannic acid.

Scarlet spirits are made by adding oxalic or tartaric acid, or both, to the single muriate.

Blooming spirits are made by adding sulphuric acid to the muriate prepared as above.

The use of tin solution is principally for the purpose of brightening or blooming other colours, and (except in scarlet and crimson dyeing) not used alone.

In the remaining lectures I shall frequently have occasion to speak of the use of these spirits.

THE PROCESSES OF STEEL MANUFACTURE.

THE manufacture of steel by a process as simple as possible, at the lowest cost and of the best quality, has called forth, especially of late years, the exercise of much inventive ability on the part of both chemists and engineers, both at home and abroad. There has resulted such a variety of differing methods that some systematic classification of the processes has become very necessary. In the *Mittheilungen des Hannoverischen Gewerbe-Vereines*, Professor Heeren publishes the complete classification, a translation of which is given below, and which will be found both instructive and of value for pur-

poses of reference. As steel occupies nearly the middle place between cast and wrought iron in its proportion of carbon, it may be prepared either by decarburizing pig iron, or, on the contrary, by causing wrought iron to absorb carbon. The processes to accomplish these ends may be arranged under five principal heads: A, Fabrication of steel by decarburization of crude or pig iron; B, by carburization of wrought iron; C, by mixing a wrought iron poor in carbon with a pig iron rich in same; D, by mixing pig iron with ore (the pig yields carbon which reduces the ore and transforms the reduced iron into steel); E, directly by means of ore; F, cast steel. Subdividing these systems, we have the following methods under each heading:—

A.—Methods by Decarburizing the Crude Iron.

1. Steel obtained by a long heating of the crude iron in an oxidizing atmosphere, the metal not being brought to fusion. (*a*) Turner's method in sand, where the deoxidation is produced by means of the oxygen in the air. (*b*) Jullien's method, in forge scales or spathic ore. This produces malleable iron. (*c*) Herzeele's method in steam. (*d*) Thomas's method in carbonic acid. The last two processes have not been employed to any great extent.

2. Natural steel: In this method, employed since the earliest times, the crude iron is melted in a refining furnace with wood charcoal, and decarburized by the ferrous oxide of the scoria. The product is purified by a repeated refining.

3. Puddling: This process is the same as the preceding, from a chemical point of view, but is practised in a reverberatory furnace heated with coal. It is necessary to purify the product by repeated refining or by transforming it into cast steel.

The construction of puddling furnaces has undergone many changes. We may distinguish (*a*) the ordinary puddling furnace with fixed hearth and heated by coal, (*b*) the same heated by lignite or peat, (*c*) the puddling furnaces of Schafhäutl and others, with mechanical rabbles designed to diminish the labour so fatiguing to the workman. These, however, have been entirely superseded by new systems. (*d*) The Danks furnace, the hearth of which is formed of a hollow cylinder placed horizontally, and turning about its axis. It gives a product of excellent quality, and is economical. The interior lining, however, is difficult to maintain. (*e*) The Ehrenworth furnace has a horizontal circular hearth turning about a vertical axis. (*f*) The Pernot furnace also has a circular sole, which, however, is not horizontal, but slightly inclined, so that during its rotation the iron and scoria run to the lowest point, and are thus in a state of continual motion; while the elevated parts of the hearth, together with the iron and scoriæ thereto adherent, are submitted to the oxidizing action of the air. Professor Heeren thinks this furnace to be the best, because it realises the advantages of mechanical puddling without needing any special lining.

4. The Bessemer process: A current of air, finely divided, is passed through the liquid crude iron. The carbon, silicon, and a part of the iron burn, and the temperature is so highly elevated that the iron, decarburized in part or transformed into steel, remains molten. It is then run into moulds.

5. Bérard's modification of the above: Air and gases are alternately introduced into the retort with different advantages.

6. Peter's process: The liquefied crude iron in a reverberatory furnace falls in the form of rain in a vertical chamber in which the furnace gases also pass, and in which air is blown so as to decarburize the metal to the desired degree.

B.—Methods by Carburization of Wrought Iron.

1. Indian or Wootz steel: Wrought iron of extraordinary purity, obtained by treating a very pure ore in small chamber furnaces by the direct method, is hammered, made into bars, cut into short pieces, and placed in small crucibles with a few green leaves. The crucibles are hermetically sealed and heated for a long time at a high temperature. The iron is transformed into steel by uniting with it this carbon contained in the leaves, and the steel even partially melts. These half-melted masses furnish the famous sword blades and plates of Persia and Damascus.

2. There are several other processes resembling the Indian, which, however, are not carried on on a large scale. There are (*a*) the Mushet process, in which wrought iron obtained by the ordinary refining method is melted with powdered wood charcoal. (*b*) The Vickers' process, analogous to the preceding, with the addition of oxide of manganese. (*c*) The Stourbridge, Brooman, Thomas, and Binks processes, based on identical principles.

3. English cemented steel: Wrought iron of the best possible quality is, in the shape of bars, packed together in clay boxes, together with wood charcoal coarsely pulverized. The heating continues for two or three weeks. Without melting, the iron is changed into steel, which by re-melting is transformed into cast steel.

4. Parry's cupola steel: Fragments of wrought iron, melted in the cupola with a large consumption of coke or wood charcoal, may be transformed into steel or even into cast iron, according to the length of the operation. This system offers an advantageous method of utilizing scrap, and requires no special apparatus.

5. Chenot's process: In this the ore is reduced by heating it progressively with coal. A non-melted iron sponge is obtained, which is ground and separated as well as possible from the gangues by the aid of a magnet. Lastly, it is mixed with carboniferous substances, and melted under pressure. The principal disadvantage of this process is the difficulty of separating the gangues without losing the steel.

6. Casehardening has for its object the transformation of the surfaces of wrought iron objects into steel. It is done in two ways. (*a*) The pieces are placed in small sheet-iron boxes and surrounded with chips of wood. The boxes are hermetically closed and heated in a forge fire, for 15 or 30 minutes, to an intense red heat. They are then removed quickly, opened, and their contents thrown into cold water, whereby the exterior steel shell is rendered as hard as glass. (*b*) The pieces are heated to a whitish red and moistened with ferrocyanide of potassium, which acts by its cyanogen on the iron, and transforms the surface into steel.

C.—Methods by Fusion of a Mixture of Cast and Wrought Iron.

The two materials may be, both, or only one of them, used in a melted state.

1. Bessemer steel, prepared by the ordinary method. The crude and wrought iron here are both liquid, while, as we have previously said, cast iron may be directly transformed into steel. The method most followed, and which leads most surely to the end in view, consists in completely decarburizing the crude iron in the converter, and in adding to the melted metallic iron a rigorously determined quantity of liquid crude iron. The carbon of the latter affects the previously decarburized iron, and makes a steel containing a given proportion of carbon.

2. Crucible steel is obtained by melting in crucibles a mixture of crude and wrought iron. The former liquefies first, and slowly melts the latter.

3. Martin's steel is similarly made, by replacing the crucible with a reverberatory furnace. The crude iron is liquefied under a thin layer of scoria on the concave hearth of a reverberatory furnace, heated to an intense red-white heat by a Siemens regenerator. Scraps of steel and wrought iron of all kinds in desired quantity are added, and the steel is run into moulds of cast iron.

D.—Methods by a Mixture of Cast Iron and Ore.

Uchatius steel: The cast iron is granulated by running it into water while molten, and the grains are melted with spathic ore, peroxide of manganese, and wrought iron in crucibles. The ferrous oxide of the spathic ore is reduced by the carbon of the cast iron, and the surplus of carbon unites with the wrought iron to make steel.

E.—Methods by Preparation direct from the Ore.

The Siemens direct process: The ore is melted alone, without addition of reducing material, at a very elevated temperature; then the iron is reduced and transformed into wrought iron or into steel by adding coal.

F.—Cast Steel.

For the purification of steel by fusion, cemented, forged, and puddled steel are employed. To improve the qualities of the steel, and notably to augment its hardness, diverse substances are added. Thus we have: 1, silver steel; 2, nickel steel; and 3, wolfram or Mushet special steel.—*Iron Trade Circular.*

THE ALLEN GOVERNOR.

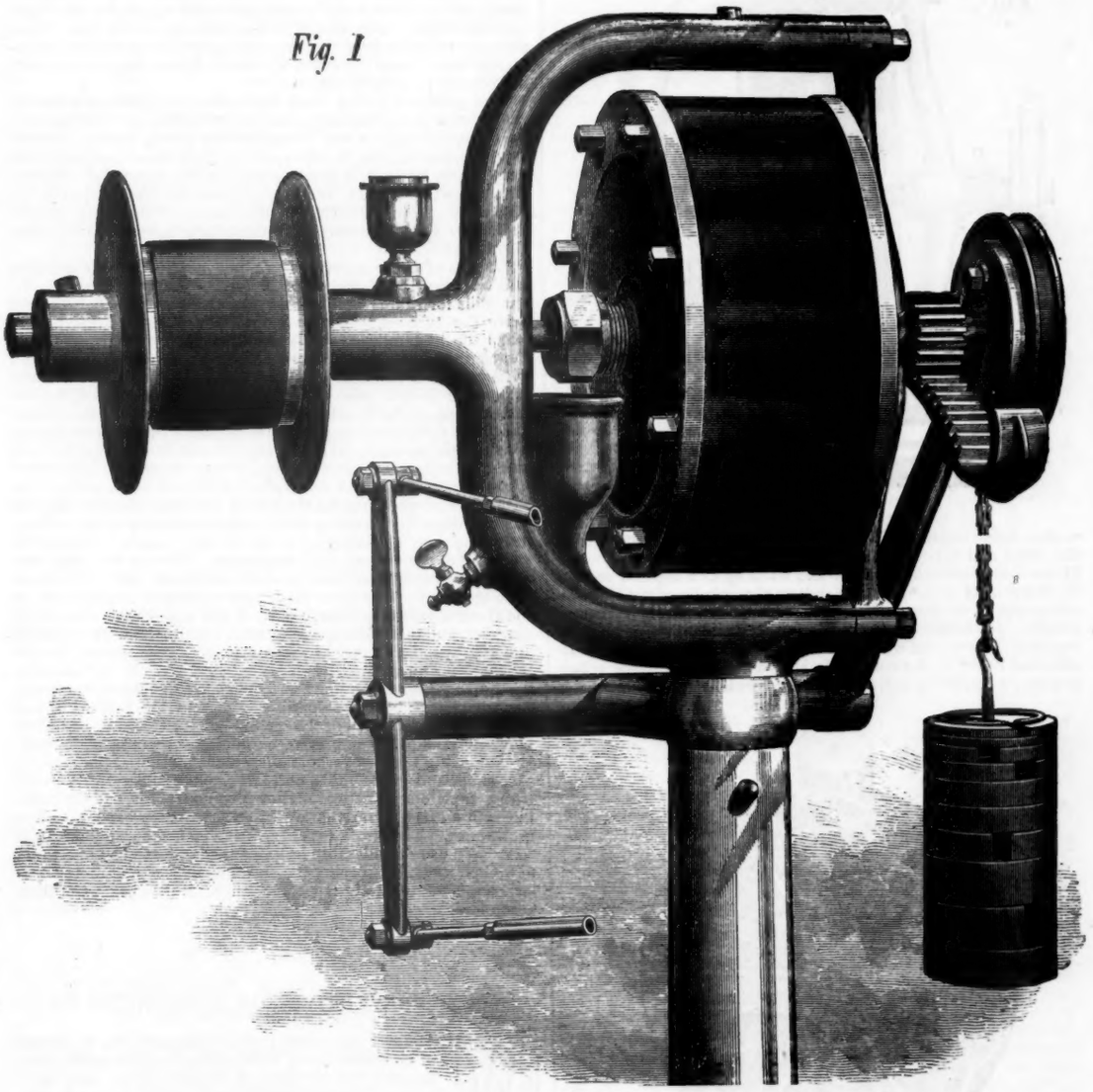
DURING the last fifty years, it has been the constant effort of thoughtful engineers and machinists in all the world to discover the best mode of maintaining a uniform speed in the working of steam engines while variations occur in the amount of work done by them. The high rate of wages paid to our artizans now, and the ever-increasing competition amongst manufacturers, make it of the first importance that the output of work from existing machinery should be maintained at the highest

point, consistent with quality of work and durability of machinery. To enable this to be done, it is necessary that the speed of the engine should not vary, however the load of the pressure of steam may vary. Suppose for instance, that it is found in a mill that all work can be well done with the main engine running at 55 revolutions. Now, if the engine varies 4 revolutions in its speed, under different loads of work or a varying pressure of steam, it is manifest that it will not be prudent to run the engine at over 52 revolutions, lest mischief be done when the speed increases. If the engine could be held within one revolution, it is clear that it could be run at 55, and practically, with its steady motion, even a little higher than that. This would give a net increase in production of from six to ten per cent. Until recently, this has not been practicable, but it has become so.

The unnecessary wear and breakage of machinery and consequent stoppage for repairs, the temporary delays for mending broken threads and the value of various fabrics injured or spoiled, are all large items in the expense of running a mill, a great part of which is the result of varying speed. The increase in quantity and improved quality of the products of cotton, woollen, iron, flour, and all other mills running at a maximum and even speed, will give a large profit over what can be produced by the same mills running with varying speed.

The ordinary Watt governor, though capable of effecting this object with a close approximation to accuracy when the variation in the power is confined within narrow limits, fails in maintaining the speed of the engine when sudden changes occur in the resistance to be overcome. The defect becomes of serious consequence in some cases, such as in the engines driving rolling mills in iron works, where the whole power of the engine has to be exerted suddenly while the iron is passing through the rolls, and the work then ceases, leaving only the resistance of the friction of the machinery to be overcome. The object sought for in the peculiar construction of the Allen governor is the thorough and accurate regulation of steam engines, and especially those with adjustable cut-offs.

Fig. 1



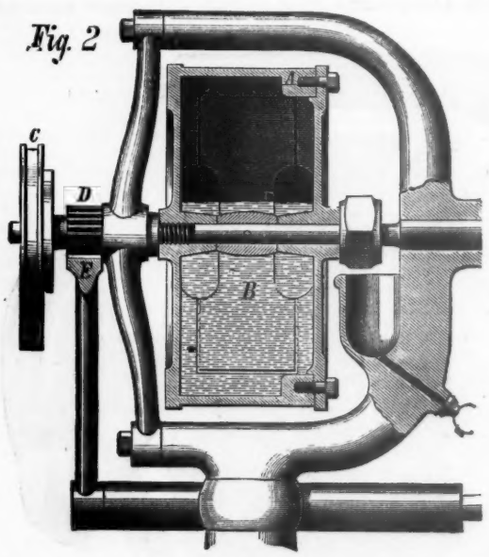
This governor was invented by R. K. Huntoon, of Boston, U. S. A., well known among engineers as the inventor of the old Huntoon governor, who has given nearly thirty years' study to regulating steam engines. It was awarded grand gold medals, at Moscow, in 1872, at Leeds, and Lyons, in 1872, and at Vienna, in 1873; and gained the first prize at the Centennial Exhibition, Philadelphia, last year.

The construction of the Allen governor will be clearly understood from Fig. 1, which represents an elevation of the governor when complete, and Figs 2 and. 3, which show sections of the

cylinder and frame. Within a corrugated cylinder, A, which has small projecting ribs on its interior periphery, and which is partially filled with oil, a paddlewheel, B, is caused to revolve by a spindle (Fig. 1) passing through one end of the cylinder, driven by a belt communicating with the fly wheel shaft.

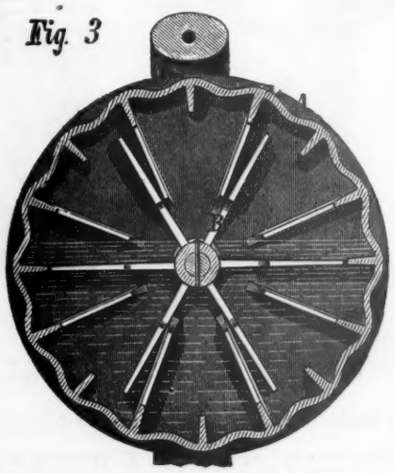
The tendency of the revolving paddlewheel is to cause the cylinder to move in the same direction. On the opposite side of the revolving spindle is a trunnion, or short spindle, fixed to the cylinder, attached to which is a wheel, C, carrying a set of movable weights suspended by a chain, the speed of the

Fig. 2



engine being regulated by the number of weights. Attached to the wheel and keyed on the end of the short spindle is a pinion, D, revolving with the cylinder and working in a toothed sector, E, the arm of which, being fixed on the spindle of the throttle valve, opens or closes it as the oil cylinder moves with the paddle, according to the variation of load thrown on the engine. When used with the variable cut-off engine, the arm is attached direct to the cut-off, as shown in Fig. 1. For other engines, a throttling valve is combined with the governor.

Fig. 3



From the above description of the Allen governor, it will be seen that the weights are raised and lowered in a nearly vertical line, and, unlike those of other governors, remain the same at every point of their suspension. The high rate of speed used acts advantageously in making the governor very sensitive; and all parts being lubricated, it works with the smallest amount of friction. This governor, in doing its work, makes an entire circuit, passing through 360 degrees. Its peculiar action allows the use of a valve of large area, thereby admitting to the engine cylinder a large boiler pressure at each stroke of the piston, and this produces, we are informed, excellent results when applied to old engines, in increasing their power or effecting a direct saving in fuel, or both. In running an engine with this governor, with high or low pressure of steam and with all variations of power, the throttle is opened wide in the morning and remains so until closed at night, thus relieving the engineer and giving him time for other duties. The governor valve, when the apparatus is not attached to a variable cut-off engine, is constructed with a double disk in a tubular form, and is perfectly balanced, there being no spindle as in the ordinary throttle valve, to interfere with its equilibrium. The valve is moved by means of a lever, and is opened and closed by a rocking motion of a steel spindle, which is covered with brass, insuring durability. Upon the least variation from the required speed, the governor can instantly exert, upon the valve or cut-off, all necessary force, up to a thousand pounds, if required.

This governor is simple in construction, not liable to get out of repair, neat in appearance, noiseless, powerful, and inexpensive.

It was patented in the United States, Great Britain, France, Belgium, and Russia, in 1870 and 1871, and since then has come very largely into use, in every case giving the utmost satisfaction. The following extract from a paper read by Mr. Frederick W. Ritson, Managing Director of the Monk Bridge Iron Works at Leeds, speaks in very complimentary terms of the Allen Governor:—

"Seven of these governors are now applied to our engines, and we have found them completely satisfactory in work. In our mills for rolling solid steel tyres, the separate engines that drive the tyre-rolls have to exert suddenly 550 horse-power, while the hydraulic power is put upon the tyre-rolls, and then the engine is suddenly relieved of the whole work excepting the friction of the machinery. With the best governor we could heretofore find, it was difficult to keep up the speed, as the momentum of the fly-wheel became used up before the governor acted sufficiently to put on the pressure of steam necessary to carry on the work, and the engine was often brought to a stand. To prevent loss from this, we employed an engine-man to stand constantly by and handle the throttle-valve and put the steam full on whenever he thought it necessary for carrying the work through; but in doing this a greater quantity of steam than necessary was frequently put on, thereby causing destructive straining of the engine and machinery. During the year the Allen Governors have been used all the above difficulties have been removed. We have no longer employed engine-men at the throttle-valves, but have opened the stop-valves wide each morning, and then these governors have maintained the required uniform speed as long as there was sufficient steam to do the work. Our engines when rolling steel tyres have indicated 550 horse-power one minute and only 130 the next minute without any change being perceptible except in the rumble of the machinery; the control of the engine being effected by the Allen Governor alone, the stop-valve remaining constantly wide open. We are using these governors upon our tyre mills, plate mills, rod, hoop, and guide mills, and large, plate shears. All work with complete satisfaction. They give no trouble, and the refilling with oil has been done so seldom as to be found no objection in practice. The strain on our gearing is not so sudden as it was. We use considerably less steam than formerly; and these new Governors, by keeping the speed of our engines more regular, enable us to get out a greater weight of iron per week than heretofore."

A NEW PREVENTIVE FOR SLIPPING BELTS.

WE doubt if any more prolific source of loss of power in its transmission from motor to work exists than through the medium of slipping belts; nor, as a moment's consideration will show, is there any ordinary mechanical defect more destructive to that system of careful economy which should be the rule in every well regulated-workshop. It is of little use to maintain and run a powerful engine, if the very power which represents the cost of so much labour and so much fuel is to be wasted before it can be applied to useful purposes. Suppose, for example, a pulley makes 100 revolutions per minute. Experiments conducted in England in 1863 proved that, when the power is transmitted by belting, there are, out of this number of revolutions, two slipped. Clearly, then, but ninety-eight per cent. of the power is forwarded to the work; and if there be numerous intermediate gearings, a still proportionally less fraction of the original efficient labour of the engine becomes

utilised. In a case of which we were recently informed, fully eight per cent. of the power was thus totally lost. For a 200 horse power engine, eight per cent. means sixteen horse power thrown away, or at a low estimate thirty-two pounds of fuel per hour burned without producing any other result than wearing out the belt and heating the pulley.

There are, of course, means for obviating slip to a certain degree. Probably those most commonly employed are the reprehensible habit of covering the periphery of the wheel with oil, resin, or adhesive matter, or of tightening the band, thereby bringing heavy pressure to bear upon the journals, increasing the friction and expediting the wear of the belt. Better than either of these is a plan which has lately come under our notice, which consists in covering the pulley with a flat band of elastic rubber and cloth made about one inch per foot shorter than the circumference, and with its inside face unvulcanized. This is stretched around the wheel and cemented fast. It is plain at once that, by this means, friction between belt and pulley must be materially increased, but to what extent the following results of experiment will best show. The tests made in our presence were conducted on a special apparatus consisting of two twelve inch pulleys on a shaft in bearings so that it could freely revolve. Upon one wheel the inventor (Mr. John W. Sutton, room 2, 95 Liberty Street, New York) had placed his cover; the other had a plain smooth face. Over the plain wheel was passed a four inch belt, one end of which was secured to the floor; to the other extremity (the slack side of the band) were hung adjustable weights. Upon the covered pulley a two inch belt was placed, which also carried a weight at one end, but at the other was attached to a hand lever. On suspending twenty-nine pounds to the small band, and some sixty pounds to the large one, it was found, on applying a pressure to the lever, that the smooth wheel was caused to slip with great readiness. Without augmenting the weight on the small band, that bearing upon the smooth wheel was increased to 108 pounds, in spite of which the latter was easily and by the same means made to slip. Above this limit, however, the power of the covered wheel did not extend, and on the addition of more weight it also began to yield. The result may therefore be summed up in the fact that the friction of twenty-nine pounds opposing the pressure of a hand lever on a two inch belt, aided by the pulley cover, was sufficient to overcome the friction of 108 pounds acting on a four inch belt, opposing a solid support, but applied to a smooth though otherwise similar pulley.

A second test was made with a smaller apparatus having an eight inch pulley and a one inch belt. The result was gained by the aid of a lever and steel yard suitably arranged. With the pulley smooth the scale marked 3½ pounds, when the belt slipped freely. When, however, the cover was applied to the surface of the same wheel, the pointer indicated nineteen pounds, or some five times the resistance. It would seem from the above that the claim of the inventor, that his device will transmit 100 per cent. more power than the smooth pulley, and consequently do twice the work before the belt will slip, is well founded, as such estimates are manifestly much below those obtained by actual trial.

So simple and effective an invention as this is worthy of the attention of machinists generally. It is readily and quickly applied, and in point of expense is inconsiderable in comparison with the economy which its employment must produce. We are informed that it is durable. The examples now in use for fourteen months exhibit no appreciable sign of wear.—*Scientific American.*

MANUFACTURES, PUBLIC WORKS, AND MACHINERY IN INDIA.

A FORTNIGHT ago the Government issued an important Report on the present condition of India, which bears conclusive evidence of the progressive condition of affairs in that wonderful empire, and is of great value to every class in English society engaged either in thinking, speaking, or acting on public matters. In general terms this Report has been noticed in the *Times;* but we propose to utilize it for the information of our readers, whose avocations, being practical, need all the detail that can be furnished, and which the public journals cannot afford to provide.

The fact that in Bombay there are 2,379 steam engines at work, that there are 28 companies for spinning and weaving cotton in the capital and 12 in the provinces, and that these are all remunerative, proves a development in the market for English machinery and of the productive trade in India when it is compared with the state of affairs in 1871. At that time there were only 11 companies in Bombay and 8 in the provinces—19, as against 40 at the present time, and these had only 19 steam engines among them, whereas now the number is trebled. And it is important to note that the machinery required there must be adapted to heavy and coarse fabrics, because just now the companies have been able to obtain a practical monopoly of this kind of manufacture, and have shut out the English goods of that character. Beginning in this way, machinery will soon find methods of improvement that shall be adapted to the cotton grown there, and be able to make up the finer and more profitable descriptions. It is well known that in England the Bengal cotton is not in favour among our cotton spinners because it is knotty, and, of course, frequently breaks, stopping the machine, and making a loss. That machinery must ultimately rectify this defect we are sure, and it is to those who are first in the field that honour and profit will ensue from the continuity of all foreign trade with the home sources of supply. The danger feared is that in consequence of the cheapness of native labour more factories will be started than the market can require, but that is a very weak fear. The enormous regions of India, to say nothing of Affghanistan, Tibet, and Burmah, had better be supplied by goods manufactured there and made by European machinery, than, which will certainly occur, they should set up machine factories of their own, or rather that European capital and organization should do it for them. The disruption of old habits is progressing, but it will take succeeding generations to complete a change; but the native industry that formerly necessitated a loom in every house is now imperilled, and the weaver and his family are driven to seek other employments. Again, the natives have no capacity at present for forming themselves into companies, as in Belgium and some parts of France; the manufacture will for a long time to come be in British hands, organized into companies. There has been a beginning also in providing the cheapest clothing in Nagpore, a very central position, and this is worked by English machinery and under European supervision. There is a growing taste for English piece-goods, and especially for those which have attained a character; indeed, for some years there has been a very fair export trade. These facts point to the importance of our machinists and inventors giving more and more attention in these days of home depression to the openings for their ingenuity and their machinery, which are continually being disclosed in various parts of the world.

In the central provinces the machinery employed in silk manufacture is actively at work, and a very extensive development of silk growth has been made. This will not only supply the home silk market with raw silk, but it will necessitate the setting up of new factories in India for that purpose. There is an opportunity in the Bengal district for some improvements in machinery adapted to the peculiarity of the silk grown there. The weaver is a rough hand and does not get finer; the machine that can do the work better would confer a great boon on Bengal industry, and pioneer the way for a new branch of engineering business, because, until a severe competition comes about, which is not likely in our time, the profit is large, and the market not difficult to please. The native work is indifferent, the pieces uneven in quality, and the price very high. Great efforts are being made to plant large mulberry grounds and to import the Chinese silk-worm. If this is successful machinery will have a fair chance of yielding a good reward for the capital it may require. The experiment is being made at Sumbulpore, in lat. 21·22 degrees, a Chinese temperature.

It is not without a sense of discomfort and regret that an observer watches the effects of a transition from hand to machine industrial operations: so many are disturbed at a period of life ill suited for such grave changes, and the market also feels the infusion of active temperaments in those who trade, as if every thing and every body partook of the marvellous force set up by machinery when connected with steam. Only the consideration that such a transformation is of incalculable advantage can reconcile the mind to the disruption of old ideas which is involved. In India, work done by hand has been remarkably good in quality. Labour is cheap, and the labourers very patient and long-working; but, even with such a start, the machine is victorious—in price, in certainty, and in quantity. Had machinery been adopted many years ago, trades and manufactures which have decayed would now be flourishing, and it is not so easy to revive a fallen industry as to make a new one. There have been, recently, much-wanted improvements in the machinery used in jute manufacture, in that of cotton, and in the preparation of sugar. To those branches our inventors and machinists will do well to give extra and prompt attention, for those are departments that will grow indefinitely, and create a splendid export trade to the benefit of the home market, because free of duties. Gunny-bag making

must be an Indian staple. The cost of labour alone will prevent any competition from whatever part of the world. The material grows there, the cost of carriage is the same whether made up or in its raw state, and the use of that package-stuff is sure to increase indefinitely. Strong rough machinery, suitable for its manufacture, is a permanent want, and one that is rapidly augmenting; and in the Patna division there is an opening for the creation of a manufacture of strong cloths. The foreign goods imported cannot compete with the native producer, and the market is therefore closed to the English merchant. If machinery suitable for that class of goods were set up, there would follow a large augmentation of produce that would create a demand not now to be supplied, and in the infinite variety of profit, arising from rapid production, benefit the entire community.

Then, of various articles, there has been a most satisfactory increase in the manufacture of gold lace, brass and copper vessels, leather goods of all kinds; and, until the cotton culture is made more perfect, the good trade in English yarns will go on improving, especially in British Burmah, a district or province which is attracting some special notice. The import of metals for these manufactures is very large and increasing, and there will follow a corresponding demand for tools, machines, and implements.

Let us look at the statements respecting metals and minerals: these are of importance to the country where they are treasured; they are likewise somewhat interesting to the engineer and machinist; and every one that seeks knowledge will be glad to learn. British Burmah is the coast on the eastern side of Bengal, and abounds in alluvial deposits of tin: recently, in the township of Malewoon, lodes or arms of that mineral have been discovered, and a firm of Rangoon merchants have taken a thirty years' lease, carried on vigorous operations, and made further discovery of a large lode in the neighbouring mountains. Discoveries of this description benefit more than any other nation the English people and the English practical men. The bountiful element in nature is no more generous than it is omnipotent: all our thought should be to learn and follow, and be thankful that by patience and the use of our powers these can be utilised to the general happiness and the individual prosperity.

Whether or not the experiments made in the district of Mysore, for obtaining in sufficient quantities the gold which we know is there treasured, is as yet uncertain. The field of enterprise is there; the crushing, and washing, and boring apparatus must be employed, and the knowledge and skill of the capitalist, engineer, and machinist, usually make a successful combination. One European has obtained privileges for "prospecting," with right of lease for given periods, of the selected places, just as in the Australian diggings. These observations apply to Madras also, whence gold has long been obtained from alluvial deposits, but in too small quantities. The question now being tested is whether the quartz-reefs may not prove more productive, most of them being more or less auriferous. So far the experiments give an average of seven pennyweights of gold to a ton of quartz. Ingenious people have sought to lease the land, ostensibly for coffee-planting, but the Government have determined that land containing mineral wealth shall not be dealt with as cultivable, and therefore makes special contracts.

Iron manufacture is a growing business in India, as in every part of the world where other conditions exist. Capital and European appliances have made the Jubbulpore iron mines so successful that the engineer who has worked them for some years has obtained a ten years' lease of the field for £200 per annum for the first five years of the lease, and a royalty of five per cent. on the out-turn for the last five years. Other concessions have been made in various places, and the works commenced. The East Indian Railway, of which we have heard much of late, will benefit greatly through the development of iron, coal, and limestone along their line. It was their engineer, Mr. Olphert, who leased the Jubbulpore mines above named, and an important company, The Bengal Iron Company, has sprung into existence in connection with this East Indian Railway property. In half-a-dozen places where iron exists, projects are ripening, and very soon a great demand for engineers and apparatus will arrive. The quality of some parts is superior to anything known, and we should not be surprised to find another town of Bessemer, with its array of chimneys and furnaces, rising from the rough places of India, as that other did in the Western States of America.

Again, not to weary the reader, we must not omit to mention the controversy respecting the iron supply in the North Western Provinces, whereon Mr. Bannerman who was deputed to examine and report spoke unfavourably of Kumaon as a site for iron manufacture, and was answered by the commissioner of the district, General Ramsay—"there is a vast field of profitable industry lying at the foot of those hills undeveloped, and the neglect of it is a wrong to the country." Now, an arrangement is made between the Kumaon Iron Works Company and the government of the North-Western Provinces, by which the government undertakes to take all the stock, and work the mines for three years, and at the end of that time restore them to the company on equitable allowances for wear and tear. This is a policy most beneficial and just; it relieves an embarrassed company, and sets a public interest in the right way. We merely observe that in the district of Mysore iron is the only metal found in any considerable quantity, and that last year the manufacture was one thousand tons.

The discovery of mineral products is not yet ended, for as roads and railways are constructed they are revealed in rapid succession. The whole of Chota Nagpore is full of mineral wealth; there are valuable quarries of chlorite or black marble, from which is made articles such as plates, dishes, cups, and other household utensils that are much sought after. Then, in the Hazareebagh district there is a talc mine from which £2,500 worth of talc is extracted yearly.

We now turn to public works. These consist of works for irrigation, railways, roads, and bridges. The importance of the first of these is evident from the physical geography of India. Stupendous mountains and arid plains characterise a vast portion of the empire. The waters which flow from the hills, as seen in the magnificence of the rivers Indus, Ganges, and the huge volume of their branches cause a saturation of the sides, so that, besides these at the foot of the Himalayas, water is only about twenty-five feet below the surface, and by digging wells along the edge of the plain it is raised by very primitive methods, and distributed over the adjacent district. Some idea of the extent of the general method—that of canals—is formed from the fact that during the last year the capital expended in Madras alone for extraordinary purposes on new works was £53,557, in addition to £26,927 for ordinary expenditure, and gave employment to many thousands of the people. It is difficult to determine the relative commercial value of these works, and that of railways for carrying purposes. At the present time the benefits conferred may be almost equal, but the railway system will win in the long run, and the canals be more available for irrigation; then machinery and steam engines will be in great request. Canals are made rapidly. From the Sutlej ten were constructed in the space of a few months, and these ran through 213 miles with a capacity for watering 100,000 acres, which work was accomplished by the district establishments without any cost to the State. In the Punjab the total area irrigated is now 1,208,073 acres, and great works are proceeding; and in the north-west provinces the capital sunk up to the end of last year reached 3,191,455, beside more than half a million on the uncompleted Agra Canal, yielding a profit in the aggregate of more than six per cent. Some are more profitable than others, but taking the carrying trade and the irrigation income together, a net result is a minimum of 5¼ per cent, and a maximum of 26⅜. There is fine employment for engineers in remodelling canals, in constructing weirs and head works with their massive foundations.

The railways almost monopolise the passenger traffic, and take a fair moiety of goods, the other being on the rivers and canals. Branch lines are in course of formation on the great line before mentioned—The East Indian. Then in Bengal the Nothern Line is being made as fast as possible, as a relief line to the Calcutta and South-Eastern Railway. Traffic steadily increases, and as soon as a satisfactory stage of development is reached on these, other lines equally useful and profitable will be begun. In Bombay the Great Indian Peninsula Company work, and the State maintains, the Nizam's State Railway of 120 miles in length. This line yields a profit of five per cent, and as soon as it can be extended will be of much greater advantage to the shareholders.

Independent of the old lines, of which in this article we do not treat,—confining our notice to last year's operations—there was in construction the Hathras and Muttra Light Railway, which is the first of a series of projects for facilitating communication with the great centres of trade and population lying off the main lines. Others are ordered, but await the accumulation of funds, which will be transferred to capital account. In the extreme corner of the Peninsula various extensions have been made, running over 237½ miles, and others will follow in the succeeding years. Where no passenger traffic is at present obtainable some lines like the Wurda Valley only carry coal, but that traffic is remunerative; it effects such a saving of time that the water transit cannot possibly compete with it, and is worked at a very little, and sometimes less, cost.

Over the Hooghly—a splendid river—a floating bridge was satisfactorily completed and opened in 1874. This kind of convenience will be adopted on many of the great rivers in the days to come; projects multiply, and the necessity for them grows

more and more vividly in the public estimation. The engineer will find steam applied, and should hasten to tender suggestions and make contracts under companies that could be readily and honestly formed, and realise all the conditions of a reasonable prospectus. In fact, bridges and roads, steam vessels, steam ferries, and all the appliances of the marine steam engineer must be in urgent request for many years to come.

We have thus hastily run over this most interesting subject, not expressing the half of what might be said as to the hopefulness of the Indian Empire becoming the choicest ground for the army of engineers and machinists who annually complete their education in England, and who are seeking for opportunities wherever they can be found—where brave hearts, steady hands, and clear heads, will enable them to develop their own powers and the fruits of their education and acquirements to their own individual advantage, and to the blessing and glory of our Eastern Empire.

CHINA MAKING IN DRESDEN.

THE fashionable mania now existing in Europe, and especially in England, which is also extending to these shores, is for old and curious china, and for odd and rare specimens prices are given which are ridiculously enormous. At an auction sale recently, a professional china dealer paid 50,000 dollars (£10,000) for a single pair of vases, after a very sharp competition, and several instances have happened where sums of nearly equal magnitude have been lavished by the wealthy in gratifying this peculiar taste. The old Dresden china is extremely valuable, more from its quaintness and richness of design than for the method of its manufacture. The latter at one time was kept a profound secret, but, like many other trade secrets, this one eventually leaked out, so that the true material came to be produced in many German towns. In a report by Mr. E. Locke, an expert deputed by the English Society for the Promotion of Scientific Industry, we find the following description of how the china is now made at the Dresden Royal Works.

The material of the porcelain body is found near Meissen, and it is washed on the works. It has the appearance of being of a loose, sandy nature. The fine particles are floated away, and carried with the water along a series of spouts till deposited in tanks of slate, after which the water is gradually drawn off. The thick slip is then put in bags about two feet long and eighteen inches wide, which are laid on their sides upon wooden hurdles plaited with wickerwood. Several layers of hurdles and bags are put upon each other, a flat board is placed on the top, and a screw is brought to bear gradually, till all the water is squeezed out. The clay is then ready for tempering. The plates and round dishes are made upon the thrower's wheel, and are then blocked upon a mould on the wheel, the foot upon it being worked with a roll. When it has left the mould, it has to be hardened and the back turned on a wheel, to give the finished outline to the foot. The bottoms of all the plates and dishes are raised up about a quarter of an inch, to allow for the dropping in the firing of them. Another man does the finishing of the edges of the plates and dishes, for there is a clear waste upon the plate of half an inch, level with the edge, and that has to be cut away with a knife. The figure makers have their labours divided. The figures are all made very thick, and the bodies of some of the figures are all pressed solid; and to get the moulds close they are put under a screw press. The parts of the figures are then taken to the finishers, who have to go over all the surface with their tools, and every fold and embossment is retouched; it is a great waste of labour. The moulds are all very dull, and the lines of fine drapery hardly to be seen.

The plaster of Paris used for the moulds seemed very hard, with a gray look, and heavy in its gravity. The cottles used by the mould maker were of a very rude description, and those for the square moulds were made of plaster bats fastened at the corners with twisted wire; the plaster seemed to take a good finish.

The figures are burned the first time, laid upon their backs, with short props dipped into ground quartz. The kiln is divided into two parts by a low dome about six feet high, with a hole in the centre of two feet. The clay is placed in the bottom part, and the gloss above, and all the saggers are luted. The ware fired in the bottom part of the kiln is hardly out of clay, and has done scarcely any contraction; it is as porous as an earthen piece in the biscuit state. It is afterwards dipped; and the glaze being in a very thin state, the dipper gets it on the piece very equal and thin. They do not use a wash for the bottoms of the saggers, but a thick bat of sagger clay, with a deal of sand in it, and it seems to answer the purpose well.

From this it will be seen that the piece of ware has to do almost all its contraction in the second burning with the glaze upon it, and with no support at all. Mr. Locke was told the contraction was one-sixth; but, from what he saw, he thought it about one-eighth. The glaze is composed of felspar from Norway, good clear quartz, and a limestone, of a bluish grey colour before it is calcined. The clay with which they make the saggers is found in the neighbourhood of Meissen; it is not a fire clay, but more after the nature of a ball clay. They use the ground grog and a sand mixed with it. Coal is obtained from Bohemia; it is of a very dull-looking black, and the cost must be considerable from the distance it has to come.—*Scientific American.*

THE VALUE OF FINE WORKMANSHIP.

"WHATEVER is worth doing is worth doing well" is, it is true, a platitude; but it has a peculiar value when applied to the machinist's art, for the difference in durability between an ordinary and a fine fit is so great that the latter is in the end the true economy. There is, of course, a large class of work in which the fit of the parts is of no practical moment, and in such cases the work may be put together as it leaves the machine tools; but for all general work, such as the connecting rods, link motions, guide rods, crossheads, and valve motions of engines, either stationary or locomotive, it pays to finish the work everywhere to a fine fit. And it may safely be said that while every piece of turned work should be finely turned, and each piece of boring carefully bored, every brass or journal-box should be filled with the smooth file and half-round scraper to its place, red marking being used to show the fit; and if this is properly done while erecting the work, there will be no danger of hot journals, or of stiff working, which too often occurs when new engines or machines are first run. It is often advanced by machine builders that "the working parts will in a few days wear down to a bearing," and it is no doubt true; but in the process of that wearing down infinite mischief is done. Suppose, for example, that a journal-box is left to wear itself to a bearing instead of being fitted to one; then the whole strain placed on the bearing will be sustained by the reduced amount of journal area at first in contact, and as a consequence the wearing will not be smooth, the degree of roughness being proportionate to the area of metal in contact, and the pressure upon the same. It is often found that the oil escaping from a newly run crosshead and slide, or from a new journal-box, appears like liquid bronze, evincing that cutting is going on; and as that cutting will cease when the working parts have come down to a bearing, it is evident that, were the brasses fitted to a bearing, the cutting would not take place. And boxes are often left slack at first, and gradually tightened up as the engine or machine is run; and there would be no necessity for this if the parts were properly fitted, not only separately, but also when put together. If a journal-box is properly fitted, the nuts may be screwed tightly home at once; and it will work smoothly and noiselessly without requiring any special attention. In lathe work we find that, no matter how carefully it is turned, it is not true; and, though outside work may be made sufficiently true for practical purposes, inside work, such as boring, will be greatly improved if fitted by hand, especially if it is put together in pieces. Eccentric straps, and pillow block or connecting-rod brasses are examples of this fact; for if we bore them to the correct size, we shall find that they close in across the joint during the process of boring, and we must, to make a good job of them, fit them to their places by hand-work. But if once properly fitted, they will work a long time without causing any lost motion.

If we turn to flat surfaces, experience has demonstrated that, no matter how carefully they may be planed or milled, they are not finished true; and though for small work, such as sewing machine work, they may be true enough, they are not so for large work. Three cast-iron surfaces, 11 by 8 inches, were recently carefully planed in a very superior planing machine; and yet it took two good hours' work with a 14-inch smooth file to file them sufficiently true to show a good bearing surface when tried together. Work may appear to be true and of a good fit when such is far from being the case, especially in the matter of flat surfaces. In fitting up connecting rods, for instance, it is no proof that, because the keys seem to have a very close

fit to the keyways and the straps to the stub ends, the fitting is well done, because the vice hand or fitter knows that these are the points to which the examiner will look to judge of the fit; and hence he is very liable to keep those edges in contact, even though the interior surfaces are hollow, and therefore not in contact at all. But it must be remembered that the wearing surface is that which is in positive working contact, and the smaller its amount, the sooner will play, looseness, or lost motion occur; and after that has once begun, the wear is much more rapid and destructive.

In the matter of all flat surfaces, it is actually cheaper to make a good job than an indifferent one. Suppose, for example we are filing out a keyway: we may use a keyway surface plate, and file it out level and out of twist; and then we know, when fitting the key, that, the keyway being right, our attention need only be directed to the key. When the latter is planed, we may apply it to the surface plate and true it up and fit it to the keyway without having to drive it in and out to try the fit. If it binds in the middle or at the edges, we may by applying the key to the surface plate, ascertain at once whether the key or the keyway requires to be eased, and thus insure not only a close fit but one fitting over the whole area.

It may in fact be said, without fear of contradiction, that no flat work can be either well or quickly done without the aid of a surface plate; nor can any work be really well done unless the parts are fitted together, and the fit tried with marking. That work is often put together as it leaves the machine tool is too true, but its durability is comparatively short-lived; and it may safely be said that, whatever extra cost is entailed, making work true and of a very fine fit is true economy. It is, *per contra*, frequently urged by engine builders that purchasers will not pay the increased cost, but the reply to this is that the cost is but little increased, because, in a majority of cases, the work may be performed actually more quickly by applying tests to ascertain its accuracy; and furthermore the application of the tests shows where the defects are, and the machinist directs his attention to remedying them; and in fitting up the work he knows just where to find them.

The standard of excellence to which work should be finished depends upon what, if any, means are to be taken to test the quality of the finished work, or whether it is to be merely subjected to a casual observation. We believe it costs much more to do good work without hand work than with it, and we are sure that good work cannot be done without actual testing, by trying the work together, and a careful application of marking, callipses, gauges, etc.; and if any of our readers are not cognisant of this fact, let them test the flatness of the most carefully manipulated piece of work, and they will be speedily convinced. Even the extra finish upon work is labour well bestowed; for in using it the operative is constantly reminded of its degree of superiority, and is just so much the more careful in using or working it. Another consideration is, that the users of machinery are not slow to appreciate excellence of workmanship, and will be ready and willing enough to pay for that which time will inevitably prove to be commercially valuable. It very often occurs that a fine adjustment of fit is neglected, because the parts are provided with a means of taking up any wear or lost motion. In many instances, however, the provision of such parts is more costly, and not more desirable, than omitting them and making the parts a good fit. The crossheads of stationary engines may be taken as a fair example of this. Solid crossheads have been known to work for years without any appreciable wear, while on the other hand it is not uncommon to find that the brass adjustable gibs and the surfaces of the guide bars are considerably worn after a few weeks' travel only. Locomotive guides and bars are much more subject to excessive duty than are those upon stationary engines; and yet it is not found desirable to provide them with any means for taking up lost motion. The link motion, etc., of a locomotive engine in England, that had run express trains for fifteen months, were taken apart, and it was found that the parts were so little worn as to be practically unimpaired; while another engine had oil on the guide bars, which was like a liquid bronze from the wear due to an improper adjustment of the gibs to the guide bars. It may also be noted that, while in many cases provision for taking up the wear is decidedly advantageous, in all such cases the wear is very likely to be excessive in consequence of an improper adjustment of the parts. In conclusion, it may justly be said that, in view of the similarity and excellence of design which many of the more prominent builds of stationary engines have attained, the quality of the workmanship promises to receive more minute attention than has in former years been paid to it; while the employment of steel and the hardening or case hardening of the working parts promises to be much more general as their great advantages become universally known.—*Scientific American.*

Chemistry applied to the Arts, Manufactures, etc.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

THE Fleets of the World.—The following return of the sailing and steam vessels of all nations in the world has been published in the *Moniteur de la Flotte*:—

Sailing Vessels.

Nation.	No. of Ships.	Tonnage.
England,	20,265	5,807,365
America,	7,288	2,390,521
Norway,	4,749	1,410,903
Italy,	4,601	1,292,076
Germany,	3,456	875,995
France,	3,858	725,048
Spain,	2,915	557,320
Greece,	2,121	426,905
Holland,	1,432	399,993
Sweden,	2,121	399,128
Russia,	1,785	391,952
Austria,	983	338,684
Denmark,	1,348	188,953
Portugal,	456	107,016
South America,	273	95,459
Central America,	153	57,941
Turkey,	305	48,289
Belgium,	54	23,344
Asiatic,	42	16,019
Africa (Liberia)	3	454
Total,	58,208	15,553,365

Steamers.

Nation.	No. of Vessels.	Gross Tonnage.	Net Tonnage.
England,	3,299	3,362,992	2,216,606
America,	605	789,728	489,717
France,	314	334,334	219,600
Germany,	226	226,888	176,322
Spain,	230	176,250	118,262
Holland,	126	134,600	85,703
Russia,	151	105,962	69,107
Italy,	114	97,582	62,929
Sweden,	219	88,660	59,549
Austria,	78	81,269	53,703
Denmark,	87	60,697	40,957
South America,	81	59,623	40,162
Norway,	122	55,874	39,420
Belgium,	35	40,700	28,568
Turkey and Egypt,	30	28,264	19,144
Portugal,	26	22,277	15,698
Asiatic,	11	10,877	6,598
Greece,	11	7,133	4,636
Central America,	6	3,132	2,058
Total,	5,771	5,686,842	3,748,739

Since the last yearly return the number of sailing vessels of all nations has increased by 950, and that of the tons by 454,367. The steamers have increased by 252 vessels and 322,350 tons. The following table shows the changes that have taken place during the last five years:—

Sailing Vessels.		*Steamers.*	
No. of Vessels.	Tons.	No. of Vessels.	Tons.
1872.....56,527	14,563,868	1872.....4,335	3,680,670
1873.....56,281	14,185,856	1873.....5,148	4,328,193
1874.....56,281	14,523,630	1874.....5,365	5,226,888
1875.....57,258	15,099,601	1875.....5,519	5,364,492
1876.....58,208	15,553,368	1876.....5,771	5,686,842

Analysis of Hydrochloric Acid for Sulphuric Acid.—In order to ascertain the quantity of sulphuric acid in the hydrochloric acid of commerce, the latter is diluted and precipitated with hydrochlorate of baryta. The gypsum in bone-black is also ascertained by a strong hydrochloric acid solution. Herr F. Sachs finds that in this process considerable quantities of hydrochlorate of baryta remain in solution, so that it is necessary to evaporate the superfluous hydrochloric acid before precipitating with the hydrochlorate.

Apparatus for giving Night Signals in the German Navy.—We extract from the *Norddeutsche Allgemeine Zeitung* the following particulars with regard to a very effective apparatus employed in the German navy for making signals, by which despatches and orders are conveyed during the night.

A reservoir of air, fed by a force pump, is connected by a communicating tube with a reservoir of very small dimensions. The jet of air that escapes with force from the tube brings with it and projects a very fine rain of petroleum into a spirit flame. The flame obtained by this process gives a very bright light. A valve serves to regulate the admission and conveyance of the petroleum. By combining flashes of short or long duration, letters or ciphers may be conventionally indicated. The theory of these combinations is identical with that of the Mose telegraph alphabet.

The Use of Steam for warming Brewing Water.—Water is often warmed by the application of steam, and then used for mashing and second brewing. According to a communication to the *Zeitschrift fur Bierbrauerei* this was lately done at a new brewery. The wort ran at first very good and clear from the returns, and in this brewing there was nothing remarkable, the beer being clear, mild, full-bodied, and bright.

After four or five brewings, however, there was a remarkable falling off in the fermentation. The yeast degenerated more and more, so that the brewer was compelled to get fresh, which after two or three applications had to be replaced by more, till at last the finest fresh and sound yeast failed to produce satisfactory fermentation.

After many fruitless attempts to ascertain the cause of this evil, it was at last observed that the hot brewing water was greasy. This water was warmed by the escape steam from an engine, which entered a closed reservoir on one side, passed over the surface of the water, and after condensation partly went out at the other side. The reservoir, on being opened, was found to be coated at the edges with a layer of grease. Consequently the steam was conveyed to the reservoir through a worm, and the evil was thus completely cured.—*Dingler's Polytechnisches Journal, November 1876.*

The Use of Picric Acid in the Treatment of Wounds.—M. Eug. Curie recommends the use of picric acid for wounds. The object is to form from the tissues or their secretions a protecting membrane against the injurious action of the air as an irritant or a means of conveying minute organisms. The picric acid is used in solution with water, or plasters saturated with this solution, or, still better, dry wadding in which picric acid has been incorporated. The last is the most convenient mode of application.—*Comptes Rendus, Oct. 30, 1876.*

A New Process of Dyeing with Artificial Alizarine.—Messrs. R. Forster's process of dyeing with artificial alizarine is as follows:—Dissolve the necessary quantity of alizarine and soap, and then neutralise the solution with sulphuric acid. The alizarine and fatty acid are precipitated in very thin flakes, which are easily attached to the mordant, so as to give very bright and fast colours.—*Les Mondes, Oct, 19, 1876.*

Change of Madder Red to Orange.—A beautiful orange is obtained by the action of nitrous acid on madder red. All that is necessary to be observed is, that the action of the nitrous acid should not last more than four or five minutes.—*Ibid.*

A Fire Warning.—A patent has been obtained in France by M. Angelin for an apparatus intended to give notice of the outbreak of fire. It is constructed in such a way, that when the temperature of the room or warehouse in which it is placed rises too high, a thermometer breaks to pieces, and the quicksilver falls into a saucer, where by its weight it acts upon a sort of clockwork so as to ring a bell.—*Deutsche Industrie Zeitung, November 23, 1876.*

The Bronzing of Paper.—In a report of a committee of the *Société d' Encouragement*, favourable mention is made of a machine invented by M. Poirier for applying bronze to lithographic impressions. The use of gilding in cards and tickets is now very extensive, and application by hand cannot keep up with the rapid work of the mechanical press. Moreover, this process is very unhealthy, as the person employed in it and others near, are continually inhaling copper dust.

Messrs. Poirier have succeeded in performing the operation mechanically. M. Poirier, sen., and Messrs Abadie each contrived to scatter and apply the metallic powder by a velvet roller to the sheet of paper rolled mechanically on a cylinder. M. Poirier thought that by the subsequent application of cylindrical brushes he had accomplished the object desired, but practice showed that something more was wanted. M. Poirier, jun., then took the matter in hand, and by completing the machine reached a satisfactory result. The fixing of the bronze is effected by a second cylinder, which turns three times as fast as the first, and glosses the bronzing at the same time as it supplies the weak parts. The drying is accomplished by velvet rollers continually cleaned by straight brushes having a transverse movement. The machine, while employing little force and managed by two attendants, can perfectly gild 500 or 600 sheets in an hour; in other words, can keep pace with the mechanical lithographic press, and supply the place of a dozen workers.

All the parts where the powder is in motion are hermetically closed, which prevents injury to health and loss of material.—*Annales du Genie Civil, Nov. 1876.*

Bronzing with Aniline.—M. O. Fiorillo's method of performing this process is as follows:—Take 10 parts of aniline red from what is called diamond fuchsine or roseine, and 5 parts of aniline purple (methyl-violet), and dissolve them in 100 parts of alcohol raised to 203 degrees F., taking care to plunge the vessel in which the mixture takes place into a water or sand bath, to promote solution. As soon as the whole is dissolved, add 5 parts of benzoic acid, and boil for five or ten minutes, until the green colour of the mixture is changed to a fine bright gilt bronze.

The colour so produced possesses great brightness, is very fast, and adheres to paper, pasteboard, wood, glass, tin, porcelain, leather, and other substances. It can be easily applied with the brush, and dries in a few minutes. It answers just as well on white ground as on coloured, and is particularly suitable for bronzing ladies' shoes and leather articles, to which it gives a beautiful bright golden bronze colour. It adheres with equal tenacity to all metals, and may consequently be used in all kinds of decoration.—*Papier-Zeitung.*

Inter-oceanic Canal in the Isthmus of Panama.—The question of cutting through the isthmus of Panama, which has occupied English, French, and American engineers for more than thirty years, has at last been settled in favour of the Nicaragua route.

The new canal, which is to join the Atlantic to the Pacific Ocean, will save ships the immense elbow they are now obliged to make through the Straits of Magellan, round the southern point of South America, before they can get from one sea to the other. It will render even greater service to general navigation than the Suez Canal, and take rank among the most gigantic enterprises of the present age.

According to the estimates of the engineers whose plans have been approved, the cost of construction will amount to £13,144,427. But several civil engineers who have made a special study of the topography of the country through which the canal is to pass, think very serious obstacles will be met with in the execution of the plan. Consequently, they reckon the cost of the gigantic enterprise at twenty millions sterling. The total length of the canal would be 180¾ miles.

For 63 miles vessels will follow the river St. John, and cross Lake Nicaragua for 56 miles, leaving about 61 miles for the length of the canal, properly so-called, which will have to be cut through solid land. There will be eighteen sluices to ensure a sufficiency of water for the ships even at low tide. Negotiations with the Powers interested in the undertaking will commence as soon as the Minister of Nicaragua is at liberty from the disorders which at present prevail in that little State.—*Technologiste, Nov. 11, 1876.*

To prevent Blacking from getting Mouldy.—This may be accomplished by mixing with blacking paste a small quantity—about half a grain—of perchloride of mercury or corrosive sublimate. If, however, there is any fear of danger from this substance, add to the paste phenol, or a few drops of phenic acid. By mixing with blacking paste a small quantity of chloride of calcium—a salt especially deliquescent—it is possible to keep the blacking in the condition of soft paste, and completely prevent its drying, without injuring its quality.—*Technologiste, Nov. 4, 1876.*

Iodide of Potassium a Remedy for the Injurious Effects of White Lead.—M. Faure communicates in a recent note to the French Academy of Sciences the result of observations he has made in a white-lead factory belonging to him, as to the efficacy of iodides in curing the painter's cholic caused by the absorption of lead into the system. He was himself the subject of his experiments. After having long suffered from this affection, with little relief from ordinary remedies, he derived great benefit from iodide of

potassium, taken in doses of three centigrammes (about half a grain), and has since always cured himself of frequent attacks, though he is very susceptible of lead emanations.

M. Faure thinks that a workman sufficiently intelligent to determine for himself the quantities he ought to take, will always obtain relief, without interrupting his work, by a daily dose of three-quarters of a grain to a grain and a half of iodide of potassium or iron.—*Comptes Rendus, lxxviii., No. 19.*

M. Milsens, the French chemist, has also found iodide of potassium very effectual in relieving workpeople who have to do with lead and quicksilver combinations. He says it should be taken in small quantities, but every day. In his opinion, it directly dissolves the lead and quicksilver combinations which are absorbed into the system, and thus facilitates its speedy removal.—*Illustrirte Gemerbe Zeitung.*

A New Electric Lamp.—From a communication to the French Academy of Sciences, it appears that M. Paul Jabloschkoff, formerly an officer in the Russian Engineers, has invented an improved electric lamp which dispenses altogether with the mechanism employed in ordinary electric lamps.

The new source of light is composed of two sticks of coal, placed parallel, at a short distance from each other, and separated by an isolating substance capable of disappearing at the same time as the coals. When the current begins to flow, the voltaic arc breaks out at the two free extremities of the two coals. The nearest layer of the isolating substance melts, is volatilised, and slowly lays bare the two sticks of coal, exactly as the wax of a taper exposes the wick, as the combustion proceeds downwards.

The idea, which at first seemed only a simplification of processes for producing electric light by dispensing with regulators, has been found, on further examination, to involve important consequences.

The heat from the combustion of the sticks of coal, which is lost in the air with regulators, is employed with the taper for the fusion and volatilisation of the isolating mixture. The composition of this mixture may vary to any extent, since most earthy substances may be used. Substances considered most incapable of fusion are volatilised when brought into the heart of the voltaic arc, as is done in the arrangement adopted for the electric taper. Sand, glass, mortar, lacs, etc., may be used. The simplest and cheapest mixture is composed of sand and pounded glass. The light obtained by the incandescence of this substance in the voltaic arc produces effects like those of the Drummond light. With a single gramme machine of the ordinary kind, three tapers may be kept burning at the same time.—*Comptes Rendus, tom. lxxxiii., No. 18.*

A Preservative against Flies.—To prevent flies from getting into the ears of horses and stinging them, it is customary to cover the head with gauze, which in very hot weather causes them great suffering, producing giddiness and sometimes even death. A veterinary surgeon has for several years adopted a singular and better expedient. He puts a drop or two of cod oil, or oil of pitch (a substance quite harmless), with a brush into the cavity of the ear, repeating the operation every week, and flies never come near the horse's head even.—*Les Mondes, Nov. 23, 1876.*

A Means of Lessening the Labour of Animals in Drawing.—It is well known that it is much harder to draw rigid and inflexible bodies than flexible and elastic ones. Thus a conveyance on springs costs less effort to draw than the same load without springs. It is proved by experience, that, if the shafts of a vehicle were attached to it by a flexible and elastic fastening, such as an india rubber band or a spiral metal spring, it could be more easily drawn and avoid the necessity of the violent pull at the collar. The buffers of locomotives not only deaden the shock of collision, but increase the impulse caused by it.

Numerous experiments in Switzerland and Germany having established this theory, Herr Schermann has applied it to practice by means of an apparatus invented by him, and called it a *Pferdeschoner*, or horse-sparer. It consists of an iron cylinder filled with india rubber rings, alternating with sheet iron discs, the whole being traversed by a rod fastened with a hook to the two ends of the apparatus, which somewhat resembles the india rubber springs used for shutting doors that have been opened. Placed between the traces and the shafts of a cart, or on the swing-bar of a plough, it produces a saving of labour which experiments have shown to amount to 17 per cent. during motion, and more than 20 per cent. on starting or stopping.

The Poisonous Properties of Glycerine.—M. Dujardin-Beaumetz undertook, together with M. Audigé, a series of experiments on the poisonous properties of glycerine, similar to those he previously made on alcohol. The results may be thus summed up :—

1. Glycerine chemically pure, when inserted under the skin of a dog in the proportion of 8 or 10 grammes (123 to 154 grains) to a kilogramme (2.2 lbs.) of the weight of the body, causes death in 24 hours.

2. All the poisonous effects (acute glycerism) resemble within certain limits those produced by alcohol.

3. The injuries to internal textures are like those caused by alcohol, which seems to prove that the action of the two substances is the same.

4. It is consequently dangerous to have very large quantities of glycerine in an establishment.—*Les Mondes, Nov. 19, 1876.*

Creosozone, a New Means of Preserving Animal Substances.—After a series of experiments on disinfection, M. G. Leube of Ulm was struck with the antiseptic properties of sulphuric acid, and was hence led to the idea of preserving animal substances by a very diluted solution of this acid. Specimens of the effect of the process appeared at the Brussels International Exhibition, consisting of pieces of beef—the oldest prepared in February, 1876—the heart, liver, spleen, and kidneys from healthy and diseased animals, a cat's skin, &c. All these were prepared by steeping them in water containing 3, or, at most, 4 per cent. of sulphuric acid. For some pieces, and among others eatable ones, 1½ to 2 per cent. of the acid was sufficient. After the dipping they were dried by exposure to the air, or in a room moderately heated.

It is not yet known whether eatable meat so prepared loses its nutritive qualities and taste, but the pieces preserved are free from bad odour, and have a very good appearance, which favours the idea that the interior is also well preserved. Experiments made on fresh skins have shown that by impregnating the inner surface with 1 per cent. of sulphuric acid, it is possible to completely prevent the disengagement of putrid gases so often perceptible in skins of commerce. A cheap method might also be thus found of disinfecting butchers' stalls and fishmongers' shops.—*Comptes Rendus, tom. lxxxiii., No. 17.*

The Anti-septic Properties of Madder Root.—A specimen of meat, says M. de Rostaing, in a communication to the *Société Chimique de Paris* has been preserved for seven months in a jar containing powdered madder, and opened a dozen times. The weight of the meat is diminished from 119 to 28 grammes, without showing any sign of putrefaction. M. de Rostaing proposes the use of madder for the preservation of corpses and the disinfection of cemeteries.—*Les Mondes.*

A Means of Preventing the Oxidation of Steel in Tempering.—To prevent the oxidation of small articles made of steel, when subjected to tempering, M. Ph. Rust recommends coating them with ferrocyanide of potassium. For this purpose two parts of finely powdered wood are taken, and one part of ferrocyanide of potassium, of which a thick pulp is made with a solution of gelatine or glue. The articles to be tempered are plunged into this mass, after having been warmed a little they are dried, and again plunged into it—the operation being repeated till the coating has attained a thickness of 2 millimetres (about a twelfth of an inch.) They may then be kept in a coal fire till they are red hot, and be tempered without fear of oxidation.—*Technologiste, Nov. 18, 1876.*

A Means of Conveying Citric Acid.—The best method of preparing and conveying citric acid is to saturate the lemon juice with powdered magnesia or magnesian rock, after which the resulting citrate of magnesia can be filtered, crystalised, and despatched.—*Technologiste, Nov. 4, 1876.*

Process for Extracting Iodine Bromine.—Mr. E. P. Alexander's method of extracting iodine from seaweed and other plants, omits all the preliminary chemical or mechanical operations that are usual. It consists in submitting the plants to the action of whitewash of a specified strength and quality. The iodine contained in the plants passes into the whitewash, which, being thus charged with iodine, is evaporated to dryness by known means, after having been treated with a solution of carbonate of potassium, in order to change all the iodine into salts of potassium. After evaporation it is calcined, to get rid of organic substances.—*Technologiste.*

Aloes Cables.—Aloes, or Manilla hemp, has been found by ten years' trial at Lens—where the manufacture of flat cables and straps for the use of mines, cranes, &c., is ex-

tensively carried on—superior to all other textile materials for these purposes, and has completely superseded the hemps of Europe. It presents a superior resistance or increase of duration beyond them, which may be reckoned at 20 per cent., its specific gravity is less, and it is not affected by moisture. These advantages combined together render aloes cables or straps about 30 per cent. cheaper than European hemp cables, even without taking into account the saving in the cost price. Aloes cables cost 16s. per 100 kilogrammes (220 lbs.), less than European hemp ones. Consequently, the total advantage may be estimated at about 50 per cent.

These cables are frequently preferred to iron wire ones, which have the serious disadvantage of liability to break unexpectedly, and requiring costly keeping in repair, though they do not last longer than aloes cables of equal weight.

The manufacture at Lens is carried on by an American machine of a hundred horse power, with steam jacket. The spinning and tarring of the cables are performed by very ingenious machinery. The cables are made quite separately, and consequently the tension of the threads, the torsion, and the twisting of the strands are perfectly uniform. There cannot possibly be any such loss of strength as occurs with ordinary processes.—*Revue Industrielle.*

The Oscillating Puddling Furnace.—M. E. Mennessier has invented a furnace for puddling mechanically. It is composed of a lower cylindrical part in sheet iron, and a vault above of fire-proof bricks, with four doors in opposite pairs. It is open at its two ends, and rests on six rollers. The fire-place and flue are fixed, as in ordinary furnaces. The gases produced by combustion heat a vertical boiler before going to the chimney. The fire-place is the only moveable part, and receives from two rods, acting on crank pins placed at each of its extremities, an oscillating motion of 90 degrees. By this motion the puddling is performed mechanically.

The most striking circumstance in this mode of puddling is a complete change in the quality of the iron produced. It has always very fine grain, with great tenacity when cold, is much harder than ordinary iron, and exactly like what is obtained from grey pig iron, completely free from phosphorus.

Further improvements in the furnace may be expected, but it has already shown the practical advantage of this mode of puddling.—Abridged from *Moniteur Industriel Belge.*

Wood in Soap.—The desire to produce cheap soap has led to its extensive adulteration. So far has this been carried, that not unfrequently what is sold for soap really contains only 20 per cent. of that article—the remaining 80 per cent. consisting of injurious salt solution. In other cases 60 per cent. of soluble glass is mixed up, with occasional additions of glue and paste.

The real value of a soap depends upon the quantity of sebacic acid and alkali it contains, which, however, must be chemically combined together, and in such proportions that they neutralise each other without any excess of either. Soap is mixed with various other substances, especially colouring and scent materials, and also pumice stone powder, sand, etc., to combine mechanical with chemical effect, which last are rarely useful, and sometimes injurious, because they attack the threads of articles washed.

It was a happy thought to choose, instead of the above substances, fine prepared wood, which, without injuring the clothes in any way, easily washes out the dirt, and to a certain extent supplies the place of a washing machine. The wood soap produced by Herr Feyerabendt of Tilsit, and consisting of tallow and cocoa oil, with the addition of ash wood powder, meets all requirements. It lessens and hastens labour, effects a considerable saving of material, is free from excessive alkali, and, by the glycerine it contains, completely prevents the hardening and chapping of the skin. In dry air it contains :—

Sebacic acid, ...	44 per cent.
Alkali, ...	6 „
Wood, glycerine, colouring matter, &c.	10 „
Water, ...	40 „

Hence it is a thoroughly genuine article, and at the moderate price of £2, 12s. od. per 100 kilogrammes (220 lbs.) is to be recommended. Perhaps the rather dark colour of the surface, caused by the action of the light on the wood, is against it; but this is not worth considering, because it does not in any way injure the action of the soap.—*Polytechnisches Notizblatt.*

Inspection of Railway Lines.—A simple and ingenious method of discovering unevenness in railway lines is adopted in America. To the locomotive sent for the purpose of inspecting the line, a small carriage is attached, in which is a paper roll several hundred feet long. During the transit this paper is unrolled by a machine at the rate of three feet to a mile, and brought under a lead pencil in the machine. The more even the course of the vehicle, the more regular are the marks made by the pencil on the paper, but any unevenness in the line produces very irregular pencil marks on the paper. Thus the whole line passed over is as it were represented on the paper, and the scale of three feet to a mile is large enough to indicate the faulty places. Similarly, a pendulum is hung between two drum-heads to ascertain the flaws in the line by the force with which the pendulum swings against the parchment. —*Arbeitgeber.*

Varnish for Wickerwork.—For covering coloured cane wickerwork with varnish, the following is recommended by the *Hessischen Gewerbeblatte.* Heat 25 grammes (about four-fifths of an ounce) of good linseed oil in a sand bath till a drop of it placed on a cold stone ceases to run when the stone is tilted, and on being lightly touched with the finger draws a long thread. Then add—at first in smaller quantities—a pound of rich copal or other varnish. The heating of the linseed oil should not be carried too far, otherwise it will not perfectly dissolve in the copal varnish; and the vessel in which this latter is heated should be large, because on the addition of the linseed oil it froths up very much. After cooling, the proper consistence is given to the varnish by mixing oil of turpentine with it. It soon dries, possesses considerable elasticity, and may be used with or without the addition of colours.

The Telegraph Cables of the World.—The number of cables sunk from 1850 to the end of 1874, with a length of 80 kilometres (about 50 miles), amounted to 206—of which 61 are no longer in use. England and France have the greatest number, the former having 19, and the latter 16. Between these two countries there are seven cables in use. In 1850 and 1851 only two cables were laid, as this kind of enterprise was then in its infancy. In 1852 and 1853 eight were laid, in 1854 seven, in 1855 nine, in 1856 and 1857 one each, in 1858 five, in 1859 thirteen, in 1860 twelve, in 1861 one, in 1862 two, in 1863 one, in 1864 six, in 1865 three, in 1866 ten, in 1867 seven, in 1868 two, in 1869 seventeen, in 1870 twenty-seven, in 1871 twenty-six, in 1872 and 1873 fourteen, and in 1874 thirteen. The longest cables to the end of 1874 are that from Ireland to Newfoundland, 1,920 miles long; that from Ireland to St. Vincent, near Pernambuco, 1,950; and that from Brest to St. Pierre, 2,570. The greatest depths at which cables had to be sunk were 13,800 feet, between Malta and Alexandria; 17,700 feet, between Ireland and Newfoundland; 18,000 feet, between England and Lisbon; and 11,370 feet, between Brest and St. Pierre.

The first cables were only 300 miles long. There is some doubt as to who first suggested the use of submarine cables—some ascribing the honour to Morse, others to Wheatstone. Be this as it may, the credit of projecting the transatlantic cable undoubtedly belongs to Cyrus W. Field, the American, who received the thanks of the United States Congress in 1864, and obtained the grand prize at the Paris exhibition in 1867.

In 1870 and 1871 direct communication was established between England and India, China, Japan, and Australia. Nothing is now wanted but a cable between San Francisco and Yokohama across the Pacific Ocean to fulfil Cyrus Field's dream of encircling the globe with telegraph wire. This great submarine cable must be in three portions—(1), from San Francisco to Honolulu, 2,087 miles long; (2), from Honolulu to Midway Island, 1,164; (3), from Midway Island to Yokohama, 2,289.

Eleven new cables, with a length of 17,000 miles, are in course of construction, or lately laid. The longest cables are between Ireland and New Caledonia, 2,188 miles long; between Aden and Mauritius, 2,777; and between Honolulu and the Fiji Islands, 2,876. There are sixteen submarine telegraph companies, with a capital of 20 millions sterling. The largest is the Anglo-American Company, with a capital of seven millions. The Eastern Submarine Company has a capital of three millions; the West India and Panama Company a capital of £1,900,000; the Eastern Extension Australia and China Company, a capital of £1,660,000, and the Western and Brazilian Company, a capital of £1,340,000.

Preparation of Cellulose.—Herr Mitscherlich of Darmstadt has invented a process for preparing a cellulose suitable for the manufacture of paper from wood—a process in which the incrusting matter of the wood is not destroyed, but only separated and rendered soluble, so that the cellulose preserves its original structure and texture. Unlike Sinclair's process, which requires that the wood be cut up very small, Herr

Mitscherlich's simply requires it to be cut as it is for stoves and fire-places.

In the working of the process use is made of a solution of quick lime, which is boiled for about six hours under a pressure of three atmospheres. After this boiling, the incrusting matter is partly dissolved in the liquor, and partly retained in the pores of the wood, from which it is forced out by a strong pressure with a suitable apparatus. By these manipulations a material is obtained which is very suitable for making white paper, and does not require to be treated with chlorides or other bleaching agents.

In this preparation use is made as much as possible of white woods, free from resin, such as poplar, willow, lime, &c. During the above operations these woods are not coloured, and the vegetable albumen, as well as the gums, is in a great measure dissolved. The success of the operation appears to depend much less on the pressure during boiling than the temperature, which, however, ought not to exceed 248 degrees F. Moreover, the use of oak wood in paper manufacture has this advantage, that tannic acid is obtained as a secondary product —an acid which, in this state, may be profitably used in the tanning of hides.—*Technologiste.*

Industrial Uses of Phosphuret of Copper and Phosphor Bronze.—In a communication to the French Academy of Sciences, Messrs. de Ruolz-Montchal and de Fontenay claim the priority in preparing and applying metallic phosphurets on a large scale. They send the Academy a specimen of phosphuret of copper, containing 9 per cent. of phosphorus. Its density is 7·764, that of cast copper being 8·850. It is brittle, has a fracture with fine grain, just like that of steel for implements. Its colour is steel grey, and it will receive a very fine polish. Trials made to determine the hardness of this phosphuret, by a comparison of its penetrating power with that of other metals, gave the following results :—

	Penetrating Power in Millimetres.
Phosphuret of Copper, . . .	2·50
Ordinary bronze of bearings, .	3·25
Red Copper, ...	5·00

It is remarkable for its stability. After being heated for several hours in crucibles lined with brasque, or damp charcoal, it loses scarcely a few thousandths of the phosphorus contained in it. It casts perfectly in dry sand, without blisters.

This phosphuret is capable of a special use which may be of importance. Two bells were sent to the Academy of the same dimensions, one cast in phosphuret of copper, containing 9 per cent. of phosphorus, the other in bronze, in the usual proportion of 78 of copper to 22 of tin. The sound of the former possesses acuteness, intensity, and quality decidedly superior to those of the other. Owing to the great affinity of phosphorus for copper, the composition of the phosphuret is the same in all its parts, and it is known that ordinary bell metal is far from exhibiting such homogeneity. It is probable that the sound can be heard much farther off. This has yet to be determined by experiment.

If the proportion of phosphorus is diminished, and reduced to a few thousandths, a result never yet obtained may be reached, *i.e.*, casting red copper in sand without perceptibly altering its physical properties in an industrial point of view. This is a circumstance which may give rise to economical uses, particularly for casting red copper articles which are now forged. Moreover, there is evident advantage to be derived from a very fusible and simple metallic compound, capable of being cast in sand or plaster-mould at will, and the hardness of which can be varied according to the required industrial uses, from the hardness of copper to that of steel for implements.

Messrs. de Ruolz-Montchal and de Fontenay combine phosphorus with bronze in the proportion of about three-thousandths. This alloy, which is harder than ordinary bronze, and consequently wears away less quickly, has the special property of presenting very little friction, which is a point of capital importance for the working parts of machines. This bronze has also the great advantage (like the phosphuret of copper that enters into its composition) of being capable of indefinitely repeated castings without any loss *industrially* appreciable.

Most of the above properties depend upon the chemical fact, that the presence of phosphorus, even in small proportion, effectually opposes oxidation of copper in metallic baths with that base, and thus prevents blisters and other accidents in casting.—*Comptes Rendus, tom. lxxxiii., No. 17.*

Albertite.—A very curious mineral known as albertite, is found in New Brunswick. It occurs in connection with calcareo-bituminous shales, and has been by some regarded as true coal, by others as a variety of jet, and by others again as more nearly related to asphaltum. The true natnre of the mineral was made the basis of a law suit in Scotland a few years ago, in which the amount involved was something more than a million of pounds sterling; as the decision settled the question of the liability to pay a royalty. It resembles asphaltum very closely, being very black, brittle, and lustrous, and like asphaltum is destitute of structure, but differs from it in fusibility and in its relation to various solvents. It differs from true coal in being of one quality throughout, in containing no traces of vegetable tissues, and in its mode of occurrence as a vein and not as a bed. The vein occupies an irregular and nearly vertical fissure, and varies from one inch to seventeen feet in thickness. It has been mined to the depth of 1,162 feet. The accompanying shales are abundantly filled with the remains of fossil fishes, and it is not improbable that from these, in part at least, the mineral was derived, existing at first in a fluid or semi-fluid state. Vegetable remains are almost entirely wanting in the shales. During twelve years since the discovery, there have been shipped 154,800 tons of albertite, chiefly to the United States, where it has been used for the maufacture of oil, and for the admixture with bituminous coal in the manufacture of illuminating gas. It is admirably adapted for either of these purposes, yielding one hundred gallons of crude oil, or 14,500 cubic feet of gas of superior illuminating power per ton. The price varies from £3 to £6, per ton.—*Iron Age, November 23, 1876.*

Practical Literature.

ELEMENTARY SCIENCE.*

THIS handsome, attractive, and well illustrated volume, is just the book we should select for a present to our boys; it finds means in most games and pastimes to illustrate the principles of Natural Philosophy, creating in youthful minds a spirit of inquiry in the right direction. It is too much to expect youthful readers to master the principles of philosophy and science for their own sake, but once create an interest in such matters, and it is wonderful how it increases to the exclusion of less healthy amusements; and it certainly is the first duty of parents and guardians to guard against the pernicious and degrading forms of literature and amusements that are so easily obtained, and are rendered so attractive now-a-days. The book under notice is written much in the same style as Joyce's Scientific Dialogues, a book in narrative fashion, and which gave us so much delight in our youthful days.

The editor of "Science in Sport" set out with the idea of preparing a modernised edition of Dr. Paris's "Philosophy in Sport made Science in Earnest," but he soon discovered that no mere verbal alteration would bring the work in harmony with the existing state of science, the result being a determination to re-write the book, treating the subject afresh; the result is, in our opinion, highly satisfactory. The chapters on energy, work, and heat, etc. we have read with much interest; the theory of heat units, and work units, is here propounded in so simple and easy a manner, that the youthful student can scarcely fail to comprehend it, and we need not say that it is of much importance to him if he is so enabled to master a subject full of importance in almost all practical questions in after life.

INDUSTRIAL BIOGRAPHY.†

MR. SMILES has provided us in this volume with some most interesting reading, consisting mainly of the records of the patience, perseverance, and struggles of early inventors and investigators in metals. It is fitting that the men who have spent their lives, and often their fortunes, for the good of the industrial community, should have their appropriate place in the library shelves of all thinking and working men; such records of success and bravery serve as examples and encouragement to others to do likewise, just as much as the life of a great warrior animates others to imitate his example. A distinguished living mechanic thus expresses himself to the author on this point:—"Kings, warriors, and statesmen, have heretofore monopolised not only the pages of history, but almost those of

* *Science in Sport made Philosophy in Earnest; being an Attempt to illustrate some Elementary Principles of Physical Knowledge by means of Toys and Pastimes.* Edited by Robert Routledge, B. Sc, F.C.S., author of "Discoveries and Inventions of the Nineteenth Century." With Illustrations. London: George Routledge and Sons. 1877.

† *Industrial Biography: Iron Workers and Tool Makers.* By Samuel Smiles, author of the "Lives of the Engineers." New Edition. London: John Murray, Albemarle Street. 1876.

biography. Surely some niche ought to be found for the mechanic, without whose skill and labour, society, as it is, could not exist. I do not begrudge destructive heroes their fame, but the constructive ones ought not to be forgotten, and there *is* a heroism of skill and toil belonging to the latter class, worthy of as grateful record, less perilous and romantic, it may be, than that of the other, but not less full of the results of human energy, bravery, and character.

The lot of labour is indeed often a dull one; and it is doing a public service to endeavour to lighten it up by records of the struggles and triumphs of our more illustrious workers, and the results of their labours in the cause of human advancement." The book is full of characteristic and interesting anecdotes, one of which we are tempted to insert, describing the manner in which James Nasmyth, the inventor of the steam hammer, literally "Scotched" a strike at the works of his firm. It runs as follows:—"A clever young man employed by the firm as a brassfounder, being found to have a peculiar capacity for skilled mechanical work, had been advanced to the lathe. The other men objected to his being so employed on the ground that it was against the rules of the trade. 'But he is a first-rate workman,' replied the employer, 'and we think it right to advance a man according to his conduct and his merits.' 'No matter,' said the workmen, 'it is against the rules, and if you do not take the man from the lathe, we must turn out.' 'Very well; we hold to our right of selecting the best men for the best places, and we will not take the man from the lathe.' The consequence was a general turn out. Pickets were set about the works, and any stray men who went thither to seek employment were waylaid, and if not induced to turn back, were maltreated or annoyed until they were glad to leave. The works were almost at a stand still. This state of things could not be allowed to go on, and the head of the firm bestirred himself accordingly with his usual energy. He went down to Scotland, searched all the best mechanical workshops there, and after a time succeeded in engaging sixty-four good hands. He forbade them coming by driblets, but held them together until there was a full freight; and then they came with their wives, families, chests of drawers, and eight-day clocks, in a steamboat specially hired for their transport from Greenock to Liverpool. From thence they came by special train to Patricroft, where houses were in readiness for their reception. The arrival of so numerous, well-dressed, and respectable a corps of workmen and their families was an event in the neighbourhood, and could not fail to strike the 'pickets' with surprise. Next morning the sixty-four Scotchmen assembled in the yard at Patricroft, and after giving 'three cheers,' went quietly to their work. The 'picketing' went on for a little while longer, but it was of no use against a body of strong men who stood 'shouther to shouther' as the new hands did. It was even bruited about that there were 'more trains to follow.' It very soon became clear that the back of the strike was broken. The men returned to their work, and the clever brassfounder continued at his turning lathe, from which he speedily rose to still higher employment."

BUILDING.*

WE have frequently had occasion to observe the invasion of the non-technical, or rather element, in all the higher departments of human knowledge and activity which distinguishes our generation. The amateur has become as a rule the inventor, and the professional his greatest impediment. Science, art, and literature, even politics and theology, look for development to the outsiders and with successful results. Sir Edmund Beckett is one of these; he attacks the traditions of the architect and the builder with an iconoclastic hand, and he will have to be answered or be the victor. We do not deem it the function of a reviewer to discuss controverted points which may arise from the perusal of such a work as that now before us, much less to utter any opinions that we may have. Our duty is confined to the rendering as faithful an analysis as possible of the design and aim of the work itself. The reader who is interested can draw his own conclusions without such aid if those conclusions are worth possessing.

Here are six chapters. I. Agreements with Architects and Builders; II. Principles of Construction; III. House-Building; plans and masonry; IV. House-Building; carpentry and fittings; V. Church-Building; VI. Domes—the Great Pyramid—Sizes of large Churches and Halls.

Finding by experience, dearly bought, that existing treatises fail to give practical information how to avoid legal and structural mistakes, Sir Edmund Beckett who "has had more than ordinary experience, with more than ordinary taste for mechanical details" during the last 25 years, and having "nothing to gain by advertising himself," claims the right of giving the public "a bit of his mind," and this he does in his usual trenchant style. He has substantively designed sundry churches and other buildings of considerable size, and has therefore a right to be heard.

The subject of architectural competition he has freely handled to the disparagement of the system, contending that it is delusive ending in extravagant cost, and abortive, unsatisfactory issues, instancing the Foreign Office, Law Courts, and the Albert Memorial. The taste of committees is bad necessarily, because the result is a compromise which eliminates all architectural idea; and the inability to judge of the relations of size when criticising the plans on paper; contending that drawings are fallacious, that the shadows are false, and the proportions unrepresented; that the system of tenders is fallacious, and that the practice of fixing a maximum price is delusive and always evaded.

So much for attack. Then follows "conditions for a competition." The drawings should be on a scale of one-eighth inches to the foot, be taken from a very distant point of view, and have no imaginary foreground whatever; that all the details be precisely to scale, and every word written in the usual style without the affectation of mediæval taste. No part of the work that can be defined by drawings or specifications is to be provided for by a sum of money. Plans, etc., to include drainage, heating apparatus, gas provisions, and everything else. Sum to be fixed with liberty to architect to suggest improvements. Committees not to be bound to accept, nor proceed, unless sureties of contractor for one-third is given.

The responsibility and powers of the architect are then set forth in remarkably shrewd observations, in which the doctrine of unlimited submission of the employer to the architect so boldly proclaimed by the Royal Institute is vigorously assailed, and the duty of asserting a public independence enforced. This is followed by anecdotes leading to another point, that of agreements with architects, wherein is disclosed some examples of sharp practice, and a kind of trades unionism, and law proceedings that followed. Advice is further given how to guard against claims on account of alterations, all tending to show the necessity for distinct and exhaustive agreements prior to consuming any work both as regards architects and builders, the latter of whom, by making rough estimates, systematically evade covenants intended to be inclusive and conclusive. Especially is this done under the present mode of tenders and estimates. Sir Edmund adds a proper form of contract that covers the ground he investigates, advises respecting extras, arbitrations, the duties of clerk of the works and division of contracts. He demurs to the application of the term "artist" to an architect and passes on.

The second chapter treats of style, contending that no new style is possible, quoting Mr. Street, and urging that the varieties of geometrical forms is limited, and novelty would be useless if it could be found. He would rather see the master-builder educate himself to his ancient position, wherein the architect was not known; for "taste and knowledge," being the real requirements, he is quite capable of their acquisition. Indeed many of the best designs have really been the fruit of a good workman's brains, and have been shaped into working order by architects' clerks. Throughout this part of the book are pungent criticisms on critics that are at once characteristic and suggestive. The choice of style in reference to churches is with him decidedly in favour of Gothic, but for houses the preference is given to the Dutch or Queen Anne style, or rather the later than that date, as being most comfortable and substantial looking, and protesting against that known as "Castellated." The earliest Gothic or English style worth imitating is the Elizabethan, because of its symmetry; he throws about with a free hand observations of great value under this division, and in the matter of churches, in a paragraph about the fallacy of orientation, asserts that the eastward position is a fancy not considered in the finest specimens, notably that of St. Peter's at Rome, where "the chancel is actually at the west." Then he adds an onslaught on the absurd rage against plaster; again claiming the authority of Mr. George Street in his celebrated paper read at the Northampton Architectural Society in 1874, and instancing examples of the scarifying work done under the plea of restoration, and on the other hand rebuking the "sham stone" fashion as a detestable sham, contending that smooth plaster finished with steel trowels, is the most handsome and real. Of the same tone are the remarks which follow about mouldings and cornices, discussing the several merits of architraves, ogee, (which is designated as the worst and feeblest of all mouldings) and other forms. His onslaught on what is technically termed the vigorous style is

* *A Book on Building, Civil and Ecclesiastical, with the Theory of Domes, and of the Great Pyramid; and a Catalogue of Sizes of Churches and other large Buildings.* By Sir Edmund Beckett, Bart. London: Crosby, Lockwood and Co. 1876.

racy, as is also his protest against the modern fashion of elaborate stone carving for London house ornamentation. This leads to a wise discourse on the fundamental question of proportions, in which is much satire that will sting; and in proof that as an architect he practises what is taught, quotes the examples of his work at Lincoln's Inn Library, and Doncaster Church, wherein both architecture and acoustics are vindicated by increasing the length. The entire chapter abounds in shrewd, hard hits, and positive, almost dogmatic, assertion most interesting to those who love the subject, or have to undertake practical matters in connection therewith.

The third chapter—House-building, consists of practical suggestions; first on the position, then on the influence and action of wind, the heat of ivy and trees, the fogs and aspect, disquisitions on general plans, which include much matter of the greatest importance in house-building, and end with a specimen of the plan of a house with all the five living and best bedrooms looking S.S.E. Fig. 1. All the parts are

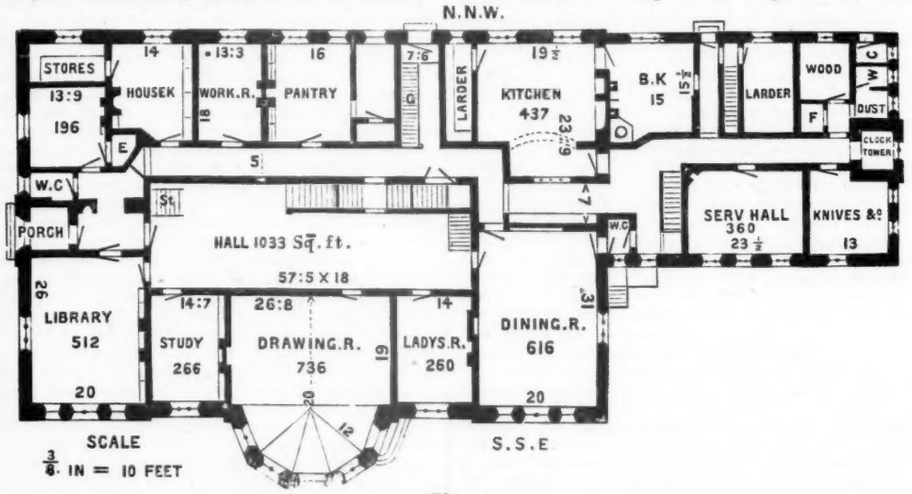


Fig. 1.

severally discussed; porch, stairs, handrails, of which, by the way an example is given which has the merit of being in proper form, (Fig. 2.), because whether in wood or marble it looks well, and the hand can be in no danger of injury in grasping that part which is usually made ridiculously big; chimneys, fire-places, doors, the sizes of rooms, bay-windows, window arches, cellars, floors, hollow walls, which are the best protectives against damp—these are the foundation of a hundred remarks of an almost proverbial nature. The author next treats of materials, stone, brick, ashlar, random walling, marble, mortar, cement, concrete, rough cast, etc., showing the proper place for them to be employed, and exposing the prevalent errors of the generation in regard thereof.

Fig. 2.

The work takes up in chap. iv. the carpentry department in house-building; such as roofs, their shapes and coverings, spouts, tanks, etc., and the nature of materials commonly used. These are followed by observations on taps, water-closets, hot water, warming fire-places, fenders, ventilation, kitchen grates, sky lights, windows, their sashes, ropes, and fastenings, of which a drawing is given descriptive of an invention by the author, very simple but effective. It allows the windows to be shut without lifting it, and prevents their shaking by the wind; a heavy short weighted lever is fixed on pivots to the top-bar of the lower sash so as to press against the side rails of the upper sash (Fig. 3); a string hangs by which the window is

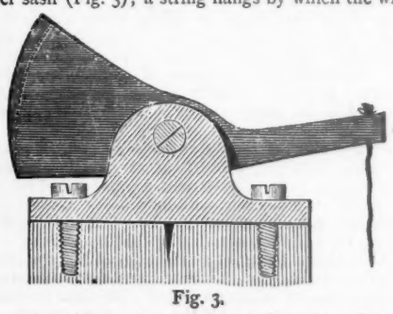


Fig. 3.

opened, and nothing can open the window when that string is again loose. The invention, like others by the author, is not patented. From windows he talks about doors and their construction, hinges, and springs; and thence about floors of all kinds, in which are interspersed most practical remarks and instruction at once artistic and easy to be understood. After a few pages on locks and bells, Sir Edward Beckett advises concerning alterations and the cost of building, and thence proceeds to teach a little about tables, especially dining tables, condemning telescopic tables as a folly, for it contains a system of elaborate sliding framework to effect what two strong sticks or bars would do better. These bars can be of any length or two or more pairs, so that for less shillings than the other costs pounds equal benefit ensues. A plan of such a table is given. The pieces of frame AB CC are only to keep the legs stiff, and AB should be of the shape marked in the drawing, so that all may be clear of the guest's legs. The loose bars can go anywhere. (Fig. 4). This is a practical suggestion of value to every reader.

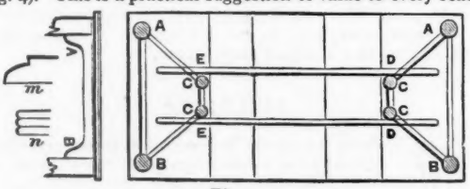


Fig. 4.

This chapter concludes with the praise of horse-hair and the bouncing of spring-bottomed chairs.

It is hardly within the range of our duty to enter upon the exceedingly interesting subject of the fifth chapter—that of Church-building. Every gentleman who intends leaving his mark in the future by erecting or indeed remodelling a church should, however, obtain the volume before us, because whatever ultimate course be taken, the whole matter is communicated in an untechnical manner, but with the keenest perception of all technicalities. It is indeed the wisdom of the teacher who succeeds solely because he employs the language and association of general life in explaining his special subject. The book ends with tables of the sizes and area of English and Foreign churches, and best of all with a good index.

Sir Edward Beckett will not be surprised to hear the voice of the scoffer; his book bristles with antagonism, and will if possible be tabooed. The style and method scarcely admits of logical controversy, for it is discursive and dogmatic, but intensely earnest and most unquestionably profitable. Those who will not see can of course turn away their eyes, but every candid mind and honest intellect will surely gather much improvement and a capacity for taking larger and more correct views on a subject of daily augmenting interest and of most important future consequences.